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HELENA, MONTANA

STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

EDITION OF 1946

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By
Deputy Commissioner

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MONTANA

STATE HIGHWAY COMMISSION

HELENA

STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

EDITION OF 1946

NO. 117

ADOPTED JANUARY 1, 1946

APPROVED BY THE U.S. PUBLIC ROADS ADMINISTRATION

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DIVISION I.

GENERAL PROVISIONS

DIVISION I

GENERAL PROVISIONS

SECTION I
DEFINITIONS AND TERMS

Whenever in these specifications and contract the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows:

1.01 A.A.S.H.O. American Association of State Highway Officials.

1.02 A.S.T.M. American Society for Testing Materials.

1.03 BIDDER. Any individual, firm, or corporation submitting a proposal for the work contemplated, acting directly or through a duly authorized representative.

1.04 BRIDGE. A structure which provides a waterway or other opening and which has a clear span of over 20 feet measured along its centerline between the inside faces of abutments, or a multiple span structure of which the sum of the individual clear spans plus the aggregate width of the intermediate supports is in excess of 20 feet.

1.05 COMMISSION. The State Highway Commission of Montana.

1.06 CONTRACT. The agreement covering the performance of the work, and the furnishing of materials in the construction of same. The contract shall include the accepted "Proposal", "Plans", "Specifications", "Special Provisions", and "Contract Bond", also any and all supplemental agreements which reasonably could be required to complete the construction of the work in a substantial and acceptable manner.

1.07 CONTRACT BOND. The approved form of security furnished by the contractor and his surety as a guaranty of good faith on the part of the contractor to execute the work in accordance with the terms of the contract.

1.08 CONTRACTOR. Party of the second part to the contract, acting directly or through his agents or employees.

1.09 CULVERT. Any structure not classified as a bridge, which provides an opening under any roadway.

1.10 ENGINEER. The State Highway Engineer, acting directly or through an assistant or other representative duly authorized by the State Highway Commission, such assistant or representative acting within the scope of the particular duties assigned to him, or of the authority given him.

1.11 HIGHWAY. The whole area between the right of way lines which is secured and reserved for use in constructing the roadway

and its appurtenances.

1.12 INSPECTOR. An authorized representative of the engineer, assigned to make any or all necessary inspections of the work performed and materials furnished by the contractor.

1.13 LABORATORY. The Testing Laboratory of the Commission at Helena or other laboratories of the Commission located at other points throughout the State, or any other laboratory which may be designated by the engineer to make tests of materials and of work involved in the contract.

1.14 MAJOR ITEM. Any item, having an original contract value in excess of 10 per cent of the total original contract amount, shall be classed as a major item.

1.15 PLANS. All drawings or reproductions of drawings, including amendments and revisions, showing the location, dimensions and details of the work contemplated and appurtenances thereto, which have been approved by the State Highway Engineer and are on file in the offices of the Commission.

1.16 PROPOSAL. The approved prepared form on which the bidder is to submit or has submitted, his, their, or its proposal for the work contemplated.

1.17 PROPOSAL GUARANTY. The security designated in the proposal, to be furnished by the bidder as a guaranty of good faith to enter into a contract with the State, if the work of constructing the improvement is awarded to him.

1.18 ROADBED. That portion of the roadway extending from shoulder line to shoulder line.

1.19 ROADWAY. That portion of the highway included between the gutter or side ditch lines, reserved for the accommodation of the traveling public, and its appurtenant structures and slopes, and all ditches, channels, waterways, bridges, etc., necessary to its correct drainage.

1.20 SPECIAL PROVISIONS. Statements modifying or changing the requirements or provisions of the specifications or adding new requirements or provisions thereto.

1.21 SPECIFICATIONS. The directions, provisions and requirements contained herein, together with all written agreements made or to be made, pertaining to the method and manner of performing the work, or to the quantities and qualities of materials to be furnished under the contract.

1.22 STATE. The State of Montana

1.23 SUB-CONTRACTOR. The individual, firm, or corporation undertaking the execution of a part of the work under the terms of the contract by virtue of an agreement between himself and the contractor, subject to the approval of the engineer.

1.24 SUBGRADE. That portion of the roadbed which is below the base course or the surface course.

1.25 SUBSTRUCTURE. All of that part of a structure below the bridge seats or below the springing lines of arches. Backwalls and parapets of abutments, and wingwalls, shall be considered as parts of the sub-structure.

1.26 SUPERSTRUCTURE. All that part of the structure above the bridge seats or above the springing lines of arches, including the flooring.

1.27 SUPPLEMENTAL AGREEMENT. A written agreement executed by the contractor and commission covering changes or alterations in plans and supplementing the original contract.

1.28 SURETY. The corporate body which is bound with and for the contractor, who is primarily liable, and which engages to be responsible for his payment of all debts pertaining to and for his acceptable performance of the work for which he has contracted.

1.29 In order to avoid cumbersome and confusing repetition of expressions in these specifications, whenever it is provided that anything is, or is to be, or to be done, if or as, or when, or where "contemplated", "required", "directed", "specified", "considered necessary", "deemed necessary", "permitted", "suspended", "approved", "acceptable", "unacceptable", "suitable", "unsuitable", "satisfactory", "unsatisfactory", or "sufficient", it shall be understood as if the expression were followed by the words "by or to the engineer with the approval of the Commission."

1.30 It should be understood thoroughly by all concerned that all things contained herein, together with the "Advertisement for Proposals" or "Notice to Contractors", "Special Provisions", and the "Contract Bond", as well as any papers attached to or bound with any of the above, also any and all supplemental agreements made or to be made, are hereby made a part of these specifications and contract, and are to be considered one instrument.

SECTION 2

PROPOSAL REQUIREMENTS AND CONDITIONS

2.01 CONTENTS OF PROPOSAL FORMS. The bidder will be furnished with a proposal form which will state the location and description of the contemplated work, and which will show the approximate estimate of the various quantities of the work to be performed and the materials to be furnished, the amount of "Proposal Guaranty" (which must accompany the proposal) and the date and time of the opening of proposals. It will also state any special provisions or requirements which vary from or are not contained in the Standard Specifications. All papers bound with or attached to the proposal form are a necessary part thereof and must not be detached.

2.02 INTERPRETATION OF ESTIMATE. The quantities scheduled in the proposal forms are to be considered as approximate and as prepared for the comparison of bids only. The unit prices to be tendered by the bidder are to be tendered expressly for the scheduled quantities as they may be increased or decreased within the restricting percentage hereinafter stipulated. Payment to the contractor will be made for the actual quantities only of work performed or materials furnished in accordance with the contract, and it is understood that the scheduled quantities of work to be done and materials to be furnished may each be increased or diminished as hereinafter provided without in any way invalidating the bid prices.

2.03 EXAMINATION OF PLANS, SPECIFICATIONS, SPECIAL PROVISIONS, AND SITE OF WORK. The bidder is required to examine carefully the site of, and the proposal, plans, specifications and contract forms for the work contemplated; it will be assumed that the bidder has investigated and is satisfied as to the conditions to be encountered in performing the work as scheduled or as at any time altered without resulting in increases or decreases of more than the restricting percentage hereinafter stipulated, and as to the character, quality and quantities of work to be performed and materials to be furnished, including increases and decreases, and as to the requirements of these specifications, special provisions, and contract. It is mutually agreed that submission of a proposal shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to all the conditions and contingencies.

2.04 PREPARATION OF PROPOSAL. The bidder must submit his proposal on the form furnished by the Commission. The blank spaces in the form must be filled in correctly for each and every item for which a quantity is given, and the bidder must state the prices (written both in words and numerals) for which he proposed or proposes to do each item of work contemplated. All proposals must be extended and totaled, and it is understood that in cases of errors or discrepancies in extension the unit prices, written in words, shall be held as governing. The bidder must sign his proposal correctly, showing his name and post office address. If the proposal is

submitted by a firm or partnership, the name and post office address of each member of the firm or partnership must be shown; if submitted by a corporation, the name of the State under the laws of which the corporation was chartered, and the names, titles, and business addresses of the President and Secretary must appear.

2.05 REJECTION OF PROPOSALS CONTAINING ALTERATIONS, ERASURES OR IRREGULARITIES. Proposals may be rejected if they show any omissions, erasures, alteration of form, additions not called for, unauthorized conditional or alternate bids, or irregularities of any kind.

2.06 PROPOSAL GUARANTY. No proposal will be considered unless accompanied by a "Proposal Guaranty" of the character and amount indicated in the proposal form, made payable to the State Highway Commission.

2.07 DELIVERY OF PROPOSALS. Each proposal must be submitted in a special envelope furnished by the Commission. The blank spaces on the envelope must be filled in correctly so as to indicate its contents clearly. If forwarded by mail, the above-mentioned envelope shall be enclosed in another addressed to the State Highway Commission at Helena, Montana; if forwarded otherwise than by mail it shall be delivered at the office of the State Highway Commission in Helena, Montana. Proposals will be received until the time stipulated in the advertisement for the opening thereof.

2.08 WITHDRAWAL OF PROPOSALS. Bidders may withdraw any proposal after it has been deposited with the Commission, provided the bidder makes his request to the Commission prior to the time set for opening the proposals on the particular project; and at the time of the opening of the proposals when such proposal is reached, it will be returned to the bidder unopened and unread.

2.09 PUBLIC OPENING OF PROPOSALS. Proposals will be opened publicly and read at the time and on the date set in the "Advertisement for Proposals" or "Notice to Contractor," by the State Highway Commission in Helena or at such other place as may be designated in the Proposal Form or Notice to Contractors. Bidders or their authorized agents are invited to be present.

2.10 DISQUALIFICATION OF BIDDERS. More than one proposal from an individual, a firm or partnership, a corporation or an association under the same or different names will not be considered. If it shall be found that any bidder is interested in more than one proposal for the work contemplated the Commission will cause the rejection of all proposals in which such bidder is interested. Any or all proposals will be rejected if there is reason for believing that collusion exists among the bidders and all participants in such collusion will not be considered in future proposals for the same work. Proposals in which the prices obviously are unbalanced may be rejected.

2.11 CONDITIONAL BIDS. A bidder, who desires to bid upon more than one project at a single letting but who desires to protect himself against receiving the award of more projects than he is

equipped to handle, may bid upon any number of projects, securing the protection desired by making the following written statement signed by the bidder and attached to the proposal form for each of the projects bid on:

> "This bid is conditional upon my (or our) receiving the award for only (insert number of projects) of the projects bid upon at this letting. If the contract for any other project, or projects, up to the number herein specified, is awarded to me (us), then this bid shall be considered withdrawn."

In case a bidder who has conditioned his bid, as above provided, is low bidder on several projects, it shall be optional with the Commission as to which of the projects is awarded him.

2.12 COMPETENCY OF BIDDERS. No contract will be awarded except to responsible bidders capable of performing the class of work contemplated. Each bidder shall submit on a standard form furnished by the Commission a certified statement of bidder's qualifications which shall be submitted as of January 1st of each year. This statement must be correctly and completely filled out and sworn to and must be placed on file with the Commission in accordance with the regulations of the Commission sufficiently in advance of the date set for the opening of the bids to allow the Commission to pass upon the qualification of the bidder prior to the opening of bids. This statement will be considered an essential part of the bid and failure to submit the statement prior to the time specified by the Commission may be deemed sufficient cause for rejection of the bid without reading it.

2.13 MATERIAL GUARANTY. Before any contract is awarded the bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the improvement, together with samples, which samples may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

SECTION 3

AWARD AND EXECUTION OF CONTRACT

3.01 CONSIDERATION OF BIDS. The comparison of bids will be based on the correct extension and summation of all items included in the proposal at prices bid. The Commission reserves the right to reject any or all proposals, or to waive technicalities as may be deemed best for the interest of the State.

3.02 AWARD OF CONTRACT. All contracts will be awarded by the Commission at Helena, to the lowest responsible bidder, within 45 days from the date of the opening of the proposals; provided, however, that should no award be made within 45 days, all proposals will be rejected.

3.03 RETURN OF PROPOSAL GUARANTY. All "Proposal Guaranties" except those of the three lowest bidders will be returned within 3 days following the date of opening bids. Should no award be made within 45 days, all proposals will be rejected and all guaranties returned.

3.04 CONTRACT BOND REQUIRED. The successful bidder, at the time of the execution of the contract, must deposit, with the Commission, a surety bond for the full amount of the contract. The form of bond shall be that provided by the Commission and the surety shall be acceptable to the Commission. The surety bond must be executed by a surety company authorized by law to transact such business in the State of Montana.

3.05 EXECUTION OF CONTRACT. The individual, firm, or corporation to whom or to which the contract has been awarded shall enter into a contract with the State at Helena within 10 days after the award. No proposal shall be considered binding upon the State until the execution of the contract.

3.06 APPROVAL OF CONTRACT AND BOND. The contract shall be approved by the Attorney General of Montana, after execution by the contractor and by the Chairman of the Commission. The bond shall likewise be approved after execution by the contractor and surety.

3.07 FAILURE TO EXECUTE CONTRACT. Failure to execute the contract or give satisfactory security, as specified, shall be just cause for annulment of the award, or of the contract, if executed, and in the event of such annulment of the award, or of the contract, the proposal guaranty shall be forfeited to the State, not as a penalty, but as liquidated damages. Award may then be made to the next lowest responsible bidder or the work may be readvertised and constructed under contract or otherwise, as the Commission decides.

SECTION 4

SCOPE OF WORK

4.01 INTENT OF PLANS AND SPECIFICATIONS. The contractor shall do all clearing and grubbing, make all excavations and embankments, do all shaping and surfacing, construct all ditches, drainage structures, bridges, and other appertaining structures, as indicated in the proposal and on the plans; remove obstructions from within the lines of the highway and shall do such additional, extra and incidental work as may be considered necessary to complete the roadway to the proper lines, grades and cross-sections, in a substantial and workmanlike manner. He shall furnish, unless otherwise provided, all implements, machinery, equipment, tools, material and labor necessary to the prosecution of the work. In short, the contractor shall construct the improvement in strict accordance with the plans, specifications, special provisions, and contract, and when completed, shall leave it in a neat and finished condition.

4.02 SPECIAL WORK. Should any construction or conditions which are not covered by the standard specifications be anticipated on any proposed work "special provisions" for such work will be stated on or attached to the proposal form and shall be considered a part of these specifications the same as though contained fully herein. Should any such special provisions or requirements conflict with these specifications, the "special provisions" shall govern.

4.03 INCREASED OR DECREASED QUANTITIES. The engineer reserves the right to make such alterations in the plans or in the quantities of work as may be considered necessary. Such alterations shall be in writing and shall not be considered as a waiver of any conditions of the contract nor to invalidate any of the provisions thereof, provided that no alteration shall involve an extension or shortening of the length of the project of more than 25 per cent, and provided that a supplemental agreement with the contractor will be necessary when alterations involve (1) an increase or decrease of more than 25 per cent of the total cost of the work calculated from the original proposal quantities and the contract unit prices, or (2) an increase of more than 25 per cent in the quantity of any one major contract item, including earth or common roadway excavation but not including excavation of any other class nor items of foundation piling. Alterations involving an increase of more than 25 per cent in the quantity of any one minor contract item will not require a supplemental agreement. Before work shall be started on any alteration requiring such supplemental agreement, the agreement setting forth an equitable adjustment of compensation satisfactory to the contractor shall be executed by the engineer and the contractor. The contractor shall perform the work as increased or decreased and no allowance shall be made for anticipated profits or loss due to such changes.

4.04 EXTRA WORK. The contractor shall perform extra work, for which there is no quantity and price included in the contract, whenever the same is ordered in writing by the engineer, and such extra work shall be done in accordance with the specifications therefore, or as directed. Such work will be paid for at a unit

price or lump sum to be agreed upon previously in writing by the contractor and the engineer; or where such a price or sum cannot be agreed upon by both parties, or where such method of payment is impracticable, the engineer shall authorize the contractor in writing to do such work on a Force Account Basis. The Highway Commission shall not pay for nor shall they be liable for any extra work performed in the absence of or prior to a written authorization or order by the engineer to the contractor covering such work. All extra work done on a Force Account Basis shall be adjusted daily upon report sheets furnished to the engineer by the contractor and signed by both parties, which daily reports shall be considered the true record of extra work done.

4.05 CONSTRUCTION AND MAINTENANCE OF DETOURS. Any existing road while undergoing improvement shall be kept continuously open to public traffic by the contractor; provided, however, that, except where otherwise indicated on the plans, the contractor may bypass traffic over a detour approved by the engineer. The contractor shall keep the road undergoing improvement, or the detour as the case may be, continuously in such condition satisfactory to the engineer, that traffic will be accommodated during the entire contract period; he shall provide and maintain in safe condition temporary approaches and crossings; he shall keep open and safely passable, intersections with trails, roads, and highways; provided, however, that snow removal will not be required of the contractor for the accommodation of traffic. The contractor shall bear all expense of constructing and maintaining such road, detours, approaches, intersections, and any accessory features without direct compensation, save as provided in (a) or (b) below.

(a) Special Detours. When the proposal form contains an item for "Maintenance of Detours", or "Removing Existing Structures and Maintaining Traffic", then the lump sum bid for such item shall cover all cost of constructing and maintaining such detour or detours, including the construction of any and all temporary bridges and accessory features and the removal of the same, and obliteration of the detour road, provided, however, that the contractor will not be required to provide right of way for temporary highways or bridges called for under this paragraph.

All or any portion of an existing structure that is suitable for use may be utilized in the detour; however, any modification of an existing structure or construction of a temporary structure shall be approved by the engineer prior to executing the work.

(b) Suspension of Work. Should the engineer, on account of unfavorable weather or other conditions not the fault of the contractor, authorize a suspension of construction operations, the contractor shall make passable and shall open to traffic such portion of the highway under improvement and such temporary roadways or portions thereof as may be agreed upon between the contractor and the engineer for the temporary accommodation of necessary traffic during the anticipated period of suspension, unless other-

wise provided in these specifications. Thereafter and until the issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon shall be by and at the expense of the State. When work is resumed the contractor shall at his own cost and expense replace or renew any work or materials lost or damaged because of such temporary use of the highway under improvement; shall remove any work or materials used in the temporary maintenance thereof by the State; and shall complete the improvement in every respect as though its prosecution had been continuous and without interference. Provided, however, that this paragraph shall not apply where the contract contains an item for "Maintenance of Detours" or "Removing Existing Structures and Maintaining Traffic" in which case the contractor shall be responsible for the maintenance of traffic during the entire term of his contract.

In case of failure of the contractor to comply with the provisions of this Section, the engineer will immediately notify the contractor to comply with the required maintenance provisions, and in the event the contractor fails to remedy unsatisfactory maintenance within 24 hours after issuance of such notice, the engineer will immediately proceed with adequate forces and equipment to maintain the roadway or structure in a satisfactory and acceptable manner and the entire cost of this maintenance will be deducted from any moneys due the contractor.

4.06 REMOVAL AND DISPOSAL OF STRUCTURES AND OBSTRUCTIONS. All obstructions, structures not designated for use, obstructing fences, etc., shall be removed and disposed of by the contractor, or otherwise, as may be directed by the engineer.

Payment for removal and disposal of structures and obstructions, unless otherwise designated in the proposal form or special provisions, shall not be paid for as a separate item but shall be considered as covered by other bid items in the contract.

It is intended that all buildings within the right of way shall be moved by the owner prior to the beginning of grading operations by the contractor. In case the buildings are not removed by the owner in time to prevent interference with grading operations, they shall be removed by the Contractor and payment therefor shall be made on a force account basis as herein provided for in Article 9.04.

4.07 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK. The contractor may use in the construction of the surface or structures any suitable stone, gravel, sand, timber or other materials found on the work that meet all the requirements of these specifications relating to character and quality for the particular use intended. Materials so used and paid for under some other item, will not be paid for as "Excavation," "Clearing," ect., except that when materials contemplated for use in embankments are otherwise used by the contractor with the result that borrow, not originally contemplated, is necessitated, the contractor will be paid on a basis that is most economical for the State. The contractor shall not

excavate or remove any material from within the highway location, which is not within the excavation as indicated by the slope and grade lines, without written authorization by the engineer.

4.08 FINAL CLEANING UP. Upon completion of the work and before acceptance and final payment shall be made, the contractor shall clean and remove from the highway and adjacent property, all surplus and discarded materials, rubbish, and temporary structures, restore in an acceptable manner all property, both public and private, which has been damaged during the prosecution of the work, and shall leave the highway in a neat and presentable condition throughout the entire length of roadway under contract.

If any gravel pit is so located as to be visible from the highway, special care shall be taken by the contractor in making the final cleanup. The gravel shall be taken out so as to leave the side banks with as uniform lines as possible, and if required by the engineer in order to produce a neat appearance, the side banks shall be neatly trimmed. The floor of the pit shall be left smooth and all piles of rock, wasted because they were too large to be handled by the crusher, shall be spread neatly over the floor of the pit or otherwise disposed of so as not to be visible from the highway. The strippings from all pits visible from the highway shall be neatly spread over the adjacent territory or shall be dragged into the pit and there spread as directed by the engineer unless the engineer orders that the strippings be left in ridges in order to act as wind breaks and snow barriers. No extra compensation shall be allowed for the final cleaning up of the gravel pits, but the cost thereof shall be included in the unit price bid for the material in the finished course or courses.

SECTION 5

CONTROL OF THE WORK

5.01 AUTHORITY OF ENGINEER. All work shall be done under the direct supervision of the engineer and his authorized assistants. To prevent misunderstanding and litigation, the engineer shall decide any and all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the manner of performance and rate of progress of said work, and shall decide all questions which may arise as to the interpretation of any or all plans relating to the work and of the specifications, and all questions as to the acceptable fulfillment of the contract on the part of the contractor, and such decision shall be final and conclusive, except that the contractor shall not be estopped from resorting to legal process in the event that the decision of the engineer with respect to the matters above enumerated is not acceptable.

5.02 PLANS AND WORKING DRAWINGS. Plans and working drawings will be furnished, and in all cases they will form a part of the contract. Road plans will show in detail minor structures, alignments, grades, cross-sections and typical cross-section of the improvement; bridge plans will be furnished separately, and will show the general layout and features and all necessary details. Such supplementary bridge and falsework plans, shop details, etc., as may be necessary shall be furnished by the contractor, but shall not be used until after approval by the engineer. No extra compensation will be allowed for such drawings. Alterations authorized by the engineer will be endorsed on approved plans or shown on supplementary sheets. Additional details relative to working drawings will be furnished as required. It shall be expressly understood that the approval by the engineer of the contractor's working drawings relates to the requirements for strength and detail and such approval will not relieve the contractor from the responsibility for errors in dimensions.

5.03 CONFORMITY WITH PLANS AND ALLOWABLE DEVIATIONS. The approved plans, profiles, and cross-sections will show the location, details, and dimensions of the work contemplated, which shall be performed in strict accordance therewith, and in accordance with the specifications. Any deviation from the plans that may be required by the exigencies of construction in all cases will be determined by the engineer and authorized in writing.

5.04 COORDINATION OF SPECIFICATIONS, PLANS AND SPECIAL PROVISIONS. All requirements of the specifications, plans and special provisions shall be binding upon the contractor. On all plans and drawings the figured dimensions shall govern in case of discrepancy between figured dimensions and scaled dimensions. Modifications of these standard specifications may be indicated by notations on the plans or in the special provisions for a particular contract; and in every case of such modification, or of discrepancies between the standard specifications and the plans and special provisions, the plans shall govern over the standard specifications and the special provisions shall govern over both the standard specifications and the plans. The contractor shall take no advantage of any error or omission in the plans or of any discrepancy between the standard specifications,

plans, and special provisions, and the engineer shall make such corrections and interpretations, in full accordance with the principles described above in this article, as may be deemed necessary for the fulfillment of the specifications, plans and special provisions as construed by him, and his decision shall be final.

5.05 COOPERATION BY CONTRACTOR. The contractor will be supplied by the engineer with two sets of approved plans, and special provisions, including authorized alterations thereof; one set of which the contractor shall keep available on the work at all times during the prosecution thereof. He shall give the work his constant attention, and shall cooperate with the Commission in every way possible. The contractor shall at all times during his absence from the work have a capable superintendent or foreman capable of reading and thoroughly understanding the plans and specifications, as his agent on the work, who shall receive instructions from the engineer or his authorized representatives. The superintendent or foreman shall have full authority to execute the orders or directions of the engineer without delay and to promptly supply such materials, tools, plant equipment and labor as may be required. Where two or more contractors are engaged upon work on the same project or section of the project, or upon work in the same vicinity, each shall be responsible to the other for any damage, injury, loss or expense which may be suffered on account of interference of operations, neglect or failure to finish work at the proper time, or for any other cause.

5.06 CONSTRUCTION STAKES. The engineer will furnish and set all survey and grade stakes necessary for the guidance of the contractor in the prosecution of the work. The contractor shall furnish, free of charge, all templets and materials other than stakes necessary for marking and maintaining points and lines given; and, without expense to the Commission, shall furnish the inspector such assistance or assistants as may be required in giving points and lines necessary to the prosecution of the work. The contractor shall be held responsible for the preservation of all stakes and marks and if in the opinion of the engineer any of the survey stakes or marks have been carelessly or wilfully destroyed or disturbed by the contractor, the cost to the Commission of replacing them will be charged against him and deducted from the payment for the work. Finished surfaces, in all cases, shall conform to the lines and grades given and as shown on the approved plans.

The crown rise of the finished surface of the roadway, from the curb or side-line to the center, shall be as shown on the typical cross-section of the plans, except at intersecting highways, or wherever to insure correct drainage or for other reasons, changes may be directed. On curves or at other places where deemed necessary, the contractor may be required to bank the roadway so that the finished surface shall slope in one direction from one side to the other.

5.07 AUTHORITY AND DUTIES OF INSPECTORS. Inspectors, employed by the Commission, will be authorized to inspect all work done, and materials furnished. Such inspection may extend to all or any part of the work and to the preparation or manufacture of the materials to be used; but such inspection shall not relieve the contractor from any obligation to perform all of the work strictly in accordance with the requirements of the specifications. In case of any dispute

arising between the contractor and the inspector as to materials furnished or the manner of performing the work, the inspector shall have the authority to reject materials or suspend prosecution of the particular work affected until the questions at issue can be referred to and decided by the engineer. The inspector shall not be authorized to revoke, alter, enlarge, or relax any requirements of these specifications, nor to finally approve or accept any portion of work, nor to issue instructions contrary to the plans and specifications. Any advice inconsistent with the requirements of the plans, specifications or contract, which the inspector may give the contractor, shall in no wise be construed as binding the engineer or the Commission in any way, nor releasing the contractor from the fulfillment of the terms of the contract. The inspector shall not be authorized to act as foreman for the contractor, nor to interfere with the management of the work.

5.08 INSPECTION. The contractor shall furnish the engineer with every reasonable facility for ascertaining whether or not the work as performed is in accordance with the requirements and intent of the specifications and contract. Any work done or materials used without suitable supervision or inspection by a Commission representative may be ordered removed and replaced at the contractor's expense.

5.09 REMOVAL OF DEFECTIVE AND UNAUTHORIZED WORK. Work done without lines and grades being given, or beyond the lines shown on the plans or as given, except as herein provided, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. All materials not conforming to the requirements of these specifications shall be considered as defective and all such materials, whether in place or not, will be rejected, and shall be removed immediately from the highway unless otherwise permitted. All work which has been rejected or condemned shall be remedied, or if necessary, removed and replaced in an acceptable manner by the contractor at his own expense. Upon failure on the part of the contractor to comply promptly with any order of the engineer made under the provisions of this Section, the engineer shall, after giving written notice to the contractor, cause defective work to be remedied, or removed or replaced, or cause unauthorized work to be removed and shall deduct the cost thereof from any compensation due or to become due the contractor.

5.10 PLANT AND EQUIPMENT. The contractor shall provide suitable equipment and plants adequate to produce acceptable work in the required quantity, and, when ordered by the engineer, shall remove unsuitable equipment from the work and discontinue the operation of unsatisfactory plants.

5.11 FINAL INSPECTION. Final inspection of the work will be made by the engineer or his authorized assistant within fifteen days after the final cleanup following completion of the project.

SECTION 6

CONTROL OF MATERIAL

6.01 SOURCE OF SUPPLY AND QUALITY. Only materials conforming to the requirements of the specifications, and approved by the engineer prior to use, shall be used in the work. The source of supply of each of the materials or finished products shall be subject to approval by the engineer before delivery is started. All materials proposed to be used may be inspected at any time during their preparation and use. The approved source of supply shall stand approved only so long as the material conforms to requirements. Any material which, after approval, has become mixed with or coated by any foreign substance during its delivery and handling shall not be used in the work.

Except as specifically stated in the special provisions, the Commission will make no attempt to designate, prior to the receipt of proposals, acceptable sources of supply for materials, and the unit prices named in the proposal shall be understood to be based upon the use of satisfactory materials.

The State may acquire and make available to the contractor the right to take materials from those sources designated on the plans and described under the special provisions, together with the right to use such property as may be specified, adjacent thereto, as may be required for stockpiles and hauling roads.

Materials taken from sources designated in the special provisions shall be paid for by the contractor at the rate specified therein. However, if the contractor fails to make the required payments, deductions sufficient to cover the cost of the material will be made from estimates due him.

If the contractor desires to use materials from sources other than those designated, he shall, at his own expense, acquire the necessary rights to take materials and to use the property for plant site, hauling roads, and other purposes, and pay all costs involved, including any which may result from an increase in length of haul. All costs of exploring and developing such other sources, shall be borne by the contractor. The use of material from other then designated sources will not be permitted until representative samples taken by the engineer have been approved by the laboratory and written authority issued for the use thereof. Approval for the use of material from such alternate sources will not be given unless the quality of the material therefrom is at least equal to the quality of material from the designated source or sources.

When sources of local materials are designated in the special provisions, the contractor shall satisfy himself as to the quantity of acceptable material available in such locations, and the State will not assume any responsibility (other than that provided in the following paragraphs) as to the quantity of acceptable material at the designated locations.

Designation of the source of supply, and of the acceptability

of the material therefrom, does not extend to the grading of the material as it may naturally come from the crusher; and it shall be the responsibility of the contractor to adjust his crusher and screens, or to remove certain portions of the material, as may be necessary to furnish gravel surfacing or other products that comply with the specifications, including the grading of the material. No additional compensation will be allowed for such adjustment of equipment or for the rejection of waste. It is understood that the engineer may order procurement of material from any portion of any area designated as a pit or quarry site and may reject portions of the deposit as unacceptable. Where the source of material is furnished by the State, all strippings, waste, rejects or other by-products of any nature shall remain the property of the State and shall be stored adjacent to the plant site as directed by the engineer.

If, due to variations in quality, or for other reasons, it should be desirable to exhaust certain of the specified sources of materials prior to the exploitation of less desirable specified sources, the same will be noted in the special provisions and plant set-ups by the contractor shall be made in the order noted.

When, in the opinion of the engineer, all of the acceptable material obtainable at all of the designated sources has been exhausted, and it becomes necessary to move the entire plant to a previously undesignated location, the State will reimburse the contractor for the actual cost of moving and erecting his plant at the new source of supply designated by the engineer. The State will reimburse the contractor at actual cost for any additional expense in connection with developing the new source of material. No allowance will be made for moving the contractor's plant from one to another of the designated sources or from one location to another at any of the individual sources named, nor for the development of the same. No extension of time will be allowed for loss of time due to moving the plant from one source of supply to another, except when all designated sources have been depleted or found otherwise unsatisfactory.

If the average haul on surfacing or other gravel or borrow material is increased or decreased by a variation in the quantity available from each of the designated sources or by a change in the designated sources by order of the engineer, an adjustment will be made either for or against the contractor, as the case may be, at the rate of 8 cents per ton-mile, or at the rate of 12 cents per mile-yard. Such adjustment, based on the determinations of the engineer, shall be full compensation for all expense the contractor may incur due to change in haul from that shown on the plans or noted in the special provisions. Provided, however, that where there is an item for overhaul on any class of material, that price will govern with respect to the price to be paid for any additional overhaul on that particular material.

Sites from which material has been removed shall be left in a neat and presentable condition upon completion of the work, and all fences removed for purposes of entry shall be replaced in as good condition as they were before being removed. Development of deposits shall be as designated by the engineer and operations shall be so carried on as not to interfere with, or increase the cost of, future

operations of the pit. The contractor shall take any necessary measures to prevent the entrance or egress of cattle from fields across which the haul road may be located.

6.02 PLANT INSPECTION. If the volume, progress of the work, and other considerations warrant, the engineer may undertake the inspection of materials at the sources of supply. Plant inspection, however, will not be undertaken until the engineer is assured of the cooperation and assistance of both the contractor and the material producer. The representative of the Commission shall have free entry at all times to such parts of the plant as concern the manufacture or production of the materials ordered, and the material producer shall furnish free of charge all reasonable facilities to assist in determining whether the material furnished meets with the requirements of the specifications. The Commission assumes no obligation to make the inspection of materials at the source of supply, and the responsibility of securing satisfactory materials rests entirely with the contractor.

The Commission reserves the right to retest all materials which have been tested and accepted at the source of supply after the same have been delivered, and to reject all materials which when retested do not meet the requirements of the specifications.

The contractor shall give sufficient notification of the placing of orders for materials to permit testing.

6.03 SAMPLES AND TESTS. Samples as prescribed or required shall be submitted by the inspector, contractor or producer for testing. Tests shall be made in accordance with the Tentative Standard Specifications for Methods of Sampling and Testing as adopted by the American Association of State Highway Officials insofar as covered therein. Test methods which are not covered in this publication shall conform to the standard specifications of the American Society for Testing Materials, or by such other recognized standard methods as may be specified or described in these specifications or designated by the engineer. Where reference is made by serial designation to test methods or specifications of either the American Association of State Highway Officials' Standards or those of the American Society for Testing Materials, it is understood that the latest approved method or specification shall apply.

The contractor shall afford such facilities as the engineer may require for collecting and forwarding samples, and shall not make use of or incorporate in the work any material represented by the samples until the tests have been made and the materials found to be acceptable in accordance with the requirements of the specifications. The contractor shall furnish without charge all samples required.

When required by the engineer or requested by the contractor, representative preliminary samples of the character and quantity prescribed shall be submitted for examination and shall be tested in accordance with the methods referred to herein. The acceptance of a preliminary sample shall not be construed as acceptance of materials from the same source delivered later, unless such materials are found to be of equal or of better quality than the preliminary

sample. Only the materials actually delivered for the work will be considered and their acceptance or rejection will be based solely on the results of the tests prescribed in these specifications.

6.04 STORAGE. Materials shall be stored so as to insure the preservation of their quality and fitness for the work. Stored materials shall be located so as to facilitate prompt inspection.

That portion of the right-of-way not required for public travel may be used for storage purposes and for the placing of the contractor's plant and equipment, but any additional space required shall be provided by the contractor at his expense. Where more than one contractor is engaged upon work on the same project or section of the project, or upon work in the same vicinity, the use of the highway right-of-way for storage purposes, for placing the contractor's plants and equipment, or for camp purposes shall be contingent upon such use not interfering with the construction operations of other contractors, and if ordered by the engineer, the contractor shall promptly move his stored materials, plant, equipment, and camp to a location where it will not interfere with any construction operation.

6.05 DEFECTIVE MATERIALS. Materials not conforming to requirements shall be rejected and removed from the work, and shall be replaced by acceptable materials and in an acceptable manner by the contractor and at his expense. The engineer may remove defective materials and charge the expense thereof against the contractor.

SECTION 7

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

7.01 LAWS TO BE OBSERVED. The contractor shall at all times observe and comply with all Federal and State Laws, and local by-laws, ordinances and regulations in any manner affecting the conduct of the work, and shall indemnify and save harmless the State and all of its officers, agents, and servants against any claim or liability arising from or based on the violation of any such law, by-law, ordinance, regulations, order or decree, whether by himself or his employees.

In carrying out work within or adjacent to National Forest, the contractor shall comply with all of the regulations of the Department of Agriculture governing the protection of forests and the carrying out of work within National Forests, and shall observe all Federal and State Sanitary Laws and regulations with respect to the performance of work in forest areas. He shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks and other structures in accordance with the requirements of the Forest Supervisor.

The contractor shall take all reasonable precaution to prevent and suppress forest fires, and shall require his employees and subcontractors, both independently and at the request of Forest Officers, to do all reasonably within their power to prevent and suppress, and to assist in preventing and suppressing forest fires, and to make every possible effort to notify a Forest Officer at the earliest possible moment of the location and extent of any fire seen by them and to extinguish the same if nearby and practicable.

It shall be the responsibility of the contractor to prevent the escape of fires set in the course of construction of the project, and to extinguish such as may escape, without expense to the State of Montana and the United States. Strict compliance with the laws governing burning operations during the designated fire season will be required at all times.

When the area through which the highway is being constructed lies within the jurisdiction of the Forest Service, or of a duly authorized State or local Fire Protection Agency, for the purpose of fighting fires in the vicinity of this project which are not caused by the contractor, the contractor, when requested by the Forest officer, shall place his employees temporarily at the disposal of the Forest officer; with the understanding, however, that payment to such employees for such services will be made by the United States or other agency concerned at not less than the current rate for such services established by the Forest Service in the area concerned, and any employees furnished will be relieved from fire fighting as soon as the Forest officer in charge finds that it is practicable to employ other help adequate for the protection of the area. If the Forest officer is on the ground, the fighting of the fire will be under his direction.

During the period from April 1st to November 15th of each year, spark arresters satisfactory to the Forest Supervisor in charge of the area concerned shall be maintained on all steam and gas driven machinery used on the project and on all flues at construction camps.

The contractor shall fully repair all damage, other than ordinary wear and tear, to roads and trails and any other improvements of the United States in the National Forests caused by the contractor's equipment.

7.02 PERMITS AND LICENSES. The contractor shall procure all permits and licenses, pay all charges and fees, and give all notices necessary and incidental to the due and lawful prosecution of the work, except that nothing herein contained shall be construed as requiring the contractor to secure right-of-way for the road proposed for improvement.

7.03 PATENTED DEVICES, MATERIALS AND PROCESSES. The Commission assumes the responsibility of defending any and all suits brought for the infringement of any patent claimed to be infringed by the design, or general type of structure provided for in plans furnished the contractor by the Commission, and to hold the contractor harmless on account of such suits or claims for royalty.

The contractor assumes the responsibility of defending any and all suits brought for the infringement of any patent claimed to be infringed in any method, process, material or machinery which he may use in the execution of the work.

The contractor must assume all responsibility for plans submitted by him for the use of the engineer and shall hold the Commission harmless from any suits, royalty or damages on account of the infringement of any patents by said plans.

7.04 RESTORATION OF SURFACES OPENED BY PERMIT. Any individual, firm or corporation wishing to make an opening in the highway must secure a permit from and will be required to deposit security with the Commission, in a suitable amount, to cover the cost of making necessary repairs, and the contractor shall not allow any person or persons to make an opening unless duly authorized by the engineer. Until the acceptance of the work performed under these specifications and contract, the contractor shall make all necessary repairs, within the time indicated in writing by the engineer, and in an acceptable manner, at any point or points in the roadway where any opening has been made by authority of the engineer. Such repair work will be paid for as "Extra Work," as indicated in these specifications and said work shall be subject to the same conditions as the work regularly performed under this contract.

7.05 FEDERAL PARTICIPATION. The attention of the contractor is directed to the provisions of the Federal Highway Act, approved November 9, 1921 (42 Statute 212), and amendments thereto. When the United States Government is to pay a portion of the cost of construction, the above Act of Congress provides that the construction work in each State shall be done in accordance with its laws and under the direct supervision of the Commission, subject to the inspection and approval of the proper Federal authority and in

accordance with the rules and regulations made pursuant thereto. The construction work, therefore, will be subject to such inspection by the properly authorized officer of the United States, or his agents, as may be necessary to meet the above requirements but such inspection will in no sense make the Federal Government a party to this contract and will in no way interfere with the rights of either party hereunder, nor will it subject the contractor to compliance with the Federal Laws relative to labor, etc., on Government contracts.

7.06 SANITARY PROVISIONS. The contractor shall provide and maintain in a neat and sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the State Board of Health or of other bodies or tribunals having competent jurisdiction. He shall commit no public nuisance.

7.07 PUBLIC CONVENIENCE AND SAFETY. The contractor shall at all times so conduct his work as to insure in the greatest possible degree the uninterrupted convenience and safety of the traffic and the public in the vicinity of the work. No road shall be closed to the public except by the express permission of the engineer. For additional instructions refer to the article on "Construction and Maintenance of Detours," Article 4.05.

7.08 BARRICADES, DANGER, WARNING AND DETOUR SIGNS. The contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient red lights, warning and danger signals and signs, provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and safety of the public. The contractor shall provide, erect and maintain acceptable and adequate detour signs at all closures and along the detour routes. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. All barricades and signs used by the contractor shall conform to the standard design attached to the plans and payment for all such services and materials shall be considered as included in the other pay items of the contract.

7.09 USE OF EXPLOSIVES. In the use and storage of explosives, the contractor shall use every precaution to prevent injury to persons and damage to property. Secure storage places shall be provided and all such places shall be clearly marked with warning signs. Only persons experienced in the handling of explosives shall be allowed to use them on the work, and no shot shall be fired until warning has been sounded and all persons within a radius of danger removed. Whenever directed by the engineer, the number or intensity of charges shall be reduced.

In the handling and storage of explosives, the contractor must comply with all Federal, State and local laws and the State will in no way be responsible for any non-compliance therewith or for damages to property or injury to persons resulting from accidental or premature explosions or from any damage attributable to the use of such explosives.

7.10 PRESERVATION AND RESTORATION OF PROPERTY, TREES, MONUMENTS, ETC. The contractor shall be responsible for the proper preservation of all public and private property, monuments, etc., along and adjacent to the roadway. He shall use suitable precautions to prevent damage to pipes, conduits and other underground structures, and shall protect from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and he shall not remove them until directed. The contractor shall not wilfully or maliciously injure or destroy shade trees or shrubs and he shall not remove or cut them without proper authority.

The contractor shall be solely responsible for any trespass upon adjacent property or injury thereto, resulting from or in connection with his operations. He shall be liable for any claims that may be made on account of the falling of trees or the deposit of debris of any kind upon private property.

The contractor shall restore, replace, or otherwise make good the loss or damage to the above described property, or upon notice the engineer may cause such restoration, replacement or indemnification, and charge same against moneys due or to become due the contractor.

7.11 RESPONSIBILITY FOR DAMAGE CLAIMS. The contractor shall save and keep harmless the State of Montana and any county, city or town thereof against and from all losses to it from any cause whatever growing out of the prosecution of the work. The engineer may retain from moneys due, or to become due, the contractor, a sufficient amount to insure the enforcement of this provision.

The contractor shall carry public liability and property damage insurance to indemnify the public for injuries or damages sustained by reason of the carrying on of the work. The public liability insurance shall be in the amount of at least $10,000 for one person and a total of $20,000 for one accident. The property damage shall be in the amount of at least $1,000 for one accident and $10,000 in the aggregate. No payment will be made on the account of a contract until the contractor has submitted adequate evidence to the Commission that he has taken out this insurance. Provided, however, that on contracts for railroad grade separation structures, the contractor shall furnish insurance in the amount and kind as set forth in paragraph 7.16.

7.12 OPENING OF SECTION OF HIGHWAY TO TRAFFIC. Whenever, in the opinion of the engineer, any roadway, or portion thereof, is in acceptable condition for travel, and is required for the convenience of the public, it may be opened to traffic as directed, and such opening shall not be held to be in any way an acceptance of the roadway, or any part of it, or as a waiver of any of the provisions of these specifications and contract. Necessary repairs or renewals made on any such section of the roadways so opened, due to defective materials or work, or to cause other than ordinary wear and tear, pending completion and acceptance of the roadway, shall come under the provisions of the article next hereunder.

If such roadway or portion thereof shall have been finished previously in a manner acceptable to the engineer, the contractor shall be relieved of the maintenance thereof; but if it has not been previously so finished, it shall be maintained in a serviceable condition by the contractor at his own expense, until such time as it is finished in an acceptable manner.

The acceptance of any portion or portions of the roadway prior to the acceptance of the work as a whole shall be understood to be an acceptance only insofar as it relieves the contractor of the maintenance of such portion or portions. It will not entitle him to payment of any part of the retained percentage, and it will not relieve him from responsibility for defective workmanship or materials.

In the case of a contract for the placing of a surface course or courses upon a grade previously constructed under a separate contract, the contractor shall be required to maintain the subgrade ahead of other operations covering the preparation of the subgrade.

7.13 CONTRACTOR'S RESPONSIBILITY FOR WORK. (a) Until its acceptance by the engineer, the improvement shall be under the care and charge of the contractor, and he shall be responsible for and shall repair and make good any injury or damage to the improvement or to any part thereof from any cause whatsoever; except that the contractor will not be held responsible for injury or damage to the improvement or any part thereof when, in the opinion of the engineer, such damage is not the result of careless, negligent or dilatory work on the part of the contractor, but is the result of unforseen natural causes beyond the control of the contractor, such as violent storms, cloudbursts and floods. The judgment of the engineer in this matter shall be final, and binding upon both parties to the contract. When a contractor has, through dilatory methods and other causes within his control, exceeded his contract time unjustifiably, and has therefore been denied an extension of his contract time, the saving clause in the next preceding sentence shall not apply, but he shall be responsible for all damage of every nature.

(b) The above saving clause shall not apply to bridge contracts. The contractor in submitting proposals for such work must be governed by his own judgment as to probable weather and stream conditions and the actual resulting conditions will never be considered as unforseen, but any loss of damage of any nature prior to acceptance of the improvement by the engineer shall be the responsibility of the contractor.

7.14 NO WAIVER OF LEGAL RIGHT. The Commission or the engineer shall not be precluded or estopped by any measurements, estimate or certificate, made or given by them, or by any agent or employee of the Commission, under any provision, or provisions, of the contract, at any time, either before or after the completion and acceptance of the work and payment therefor pursuant to any measurement, estimate or certificate, from showing the true and

correct amount and character of the work performed and materials furnished by the contractor, or from showing, at any time, that any such measurement, estimate, or certificate is untrue or incorrectly made in any particular, or that the work or materials, or any part thereof do not conform in fact to specifications and contract, and the Commission shall have the right to reject the whole or any part of the aforesaid work or materials, should the said measurement, estimates, certificate or payment be found, or be known to be, inconsistent with the terms of the contract, or otherwise improperly given, and the Commission shall not be precluded and estopped, notwithstanding any such measurement, estimate, certificate and payment in accordance therewith, from demanding and recovering from the contractor and his surety such damage as it may sustain by reason of his failure to comply with the terms of the specifications and contract. Neither acceptance by the Commission, the engineer or any agent or employee of the Commission, nor any certificate by the Commission for payment of money, nor any payment for, nor acceptance of the whole or any part of the work by the Commission or engineer, nor any extension of time nor any possession taken by the Commission or its employees, shall operate as a waiver of any portion of the contract or of any power herein reserved by the Commission, or any right to damages herein provided, nor shall any waiver of any breach of the contract be held to be a waiver of any other or subsequent breach.

7.15 FAMILIARITY WITH LAWS, ETC. The contractor is assumed to have made himself familiar with all Federal and State laws and local bylaws, ordinances and regulations which in any manner affect the work or those engaged or employed in the work and no plea of misunderstanding will be considered on account of his ignorance thereof. If the bidder or contractor shall discover any provision in the plans, specifications or contract which is contrary to or inconsistent with any such law, bylaw, ordinance or regulations, he shall forthwith report it to the Commission in writing.

The contractor's attention is directed particularly to the provisions and requirements of the Workmen's Compensation Act, being Chapter 256 of the Political Codes, Revised Codes of Montana and amendments thereof; also to the statutes regulating the hours of employment on public work.

In the performance of all work under these contracts, the contractor shall give such preference to honorably discharged soldiers and sailors of the United States and to disabled civilians recommended by the State Rehabilitation Bureau as is provided for in Section 5653 of the Revised Codes of Montana, 1935, as amended by Chapter 66 of the Laws of 1937, and by Chapter 160, Session Laws of 1943.

7.16 RESPONSIBILITY OF CONTRACTOR FOR DAMAGE TO RAILWAYS AND LIKE PROPERTIES. At points where the Contractor's operations are adjacent to properties of railway, telegraph, telephone and power companies, or are adjacent to other property, damage to which might result in very considerable expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall be solely and directly responsible to the owners and operators of such properties for any damage, injury, expense, loss, inconvenience or delay, or for any suits, actions, or claims of any character brought on account of any injuries or damages which may result from the carrying out of the work to be done under this contract, and, if required by the Commission, he shall give bond or furnish Protective Public Liability and Property Damage Insurance in an amount specified by the Commission, to each corporation, company, partnership, or individual owning or operating any of the properties affected, in guarantee of this responsibility.

Unless otherwise provided for in the special provisions, he shall, on contracts including railroad grade separation projects involving work within railroad right of way, give bond or carry insurance of the following kinds and amounts:

(a) Contractors' Public Liability and Property Damage Liability Insurance:

The contractor shall furnish evidence to the Highway Department that, with respect to the operations he performs, he carries regular Contractors' Public Liability Insurance providing for a limit of not less than $25,000.00 for all damages arising out of bodily injuries to or death of one person, and subject to that limit for each person; a total limit of $50,000.00 for all damages arising out of bodily injuries to or death of two or more persons in any one accident, and regular Contractors' Property Damage Liability Insurance providing for a limit of not less than $25,000.00 for all damages arising out of injury to or destruction of property in any one accident and, subject to that limit per accident, a total (or aggregate) limit of $50,000.00 for all damages arising out of injury to or destruction of property during the policy period.

If any part of the work is sublet, similar insurance shall be provided by or in behalf of the sub-contractors to cover their operations.

(b) Contractors' Protective Liability and Property Damage Liability Insurance.

The contractor shall furnish evidence to the Highway Department, that, with respect to the operations performed for him by sub-contractors, he carries in his own behalf regular Contractors' Protective Public Liability Insurance providing for a limit of not less than $25,000.00 for all damages arising out of bodily injuries to or death of one person, and, subject to that limit for each person; total limit of $50,000.00 for all damages arising out of bodily injuries to or death of two or more persons in any one accident, and regular Contractors' Protective Property Damage Liability Insurance providing for a limit of not less than $25,000.00 for all damages arising out of injury to or destruction of property in any one accident, and, subject to that limit per accident, total (or aggregate) limit of $50,000.00 for all

damages arising out of injury to or destruction of property during the policy period.

(c) Railroads' Protective Public Liability and Property Damage Liability Insurance.

In addition to the above, he shall furnish evidence to the Highway Department that, with respect to the operations he or any of his subcontractors perform, he has provided for, and in behalf of the Railway Company, regular Protective Public Liability Insurance providing for a limit of not less than $25,000.00 for all damages arising out of bodily injuries to or death of one person, and subject to that limit for each person; total limit of $50,000.00 for all damages arising out of bodily injuries to or death of two or more persons in any one accident, and regular Protective Property Damage Liability Insurance providing for a limit of not less than $25,000.00 for all damages arising out of injury to or destruction of property in any one accident, and subject to that limit per accident, total (or aggregate) limit of $50,000.00 for all damages arising out of injury to or destruction of property during the policy period.

Where the amounts of insurance specified herein are carried by the contractor, furnishing of the Public Liability and Property Damage specified in the second paragraph of Section 7.11 will not be required.

If the construction work on portions of the right of way secured by easement from the railroad company is in such close proximity to railway tracks that the railway company deems it necessary to provide flagmen or other means of protection for their traffic, all such expense shall be repaid to the railway company by the Contractor or deducted from any compensation due or to become due the Contractor. Likewise the cost of cabling telephone or telegraph wires or other expense incurred in protecting such wires shall be repaid by the Contractor.

7.17 RIGHT OF WAY. All right of way for the roadway shall be provided by the Commission without cost to the contractor. All right of way may not have been obtained at the time when the bids are opened, and the contract let, and in that case the award will be made conditional upon the contractor not beginning work on sections where the right of way has not been secured until that right of way has been obtained and the contractor is authorized to enter upon those sections. The submission of a bid will be construed as an acceptance of this condition by the bidder, and no claim for damage or loss of anticipated profits on account of unavoidable delay in securing right of way will be considered by the commission. If the contract is materially delayed because of right of way difficulties, due consideration will be given by the Commission in extending the contract time to make proper allowance therefor.

7.18 GASOLINE TAX REFUNDS. It is understood and agreed that the unit prices bid by the contractor include the state tax on all gasoline used in the performance of the work, including that used

in the operation of stationary gas engines and for all other uses, as well as that used in motor vehicles; and it is further agreed that if any refund of said tax is received by the contractor or by his subcontractors or employees, the amount thereof shall be credited to the State Highway Commission on accounts due to the contractor under this contract, or shall be paid to the State Highway Commission by the contractor, in cash or by certified check.

SECTION 8

PROSECUTION AND PROGRESS

8.01 ASSIGNING OR SUBLETTING OF CONTRACT. (a) Assignment of Contract. The contractor shall not assign, transfer, convey or otherwise dispose of his right, title or interest therein to any other person, firm or corporation without the written consent of the Commission.

The Commission will not recognize nor accept an advance "blanket" assignment by the contractor to any bank or other third party under the provisions of which all payments due or to become due the contractor are proposed to be paid direct to such third party rather than to the contractor. The Commission will recognize a request by the contractor to deposit payments to his credit in any stipulated bank.

(b) Subletting. The contractor shall perform with his own organization and with the assistance of workmen under his immediate superintendence, work of a value not less than 80 per cent of the value of all work embraced in the contract exclusive of items not commonly found in contracts for similar work, or which require highly specialized knowledge, craftsmanship, and/or equipment not ordinarily available in the organizations of contractors performing work of the character embraced in the contract. The unit prices bid shall be used in determining the value of the work subcontracted regardless of any price agreement between the contractor and subcontractor.

If any bidder shall state in his proposal the particular item or items of work which he proposes to sublet and shall name therein the subcontractor to whom he proposes to sublet such work in the event of an award to him, such item or items of work may be performed by such subcontractor notwithstanding the 80 per cent limitation above mentioned, provided that the subcontractor named in the proposal is a contractor of recognized standing, has a record of satisfactory performance, and the work proposed to be sublet does not constitute a major portion of the work embraced in the contract. Any bidder who shall name a subcontractor in his proposal shall attach thereto a certificate that the use of the name of such subcontractor was with his knowledge and consent. Any subcontractor so named in any bid may be required to submit questionnaires to establish his experience and financial ability. The naming of a subcontractor in any such proposal will not insure approval of the proposed subletting of work to him, and in the event of disapproval of such subletting, the contractor shall perform such item or items of work with his own organization, in full compliance with all applicable terms of his contract.

No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the State Highway Commission or its authorized representative. Requests for permission to sublet, assign or otherwise dispose of any portion of the contract shall be in writing and accompanied by the consent of surety and by a showing that the organization which will perform the work is particularly experienced and equipped for such work.

Each and every subcontract shall be in writing and shall provide that the work be performed in accordance with all the provisions of the agreement or contract obligating the general contractor. Certified copies of all subcontracts shall be furnished to the Commission for approval before execution by the parties to such subcontract and a copy of such approved subcontract shall be filed with the Commission after execution by the parties thereto.

Written consent to sublet, assign or otherwise dispose of any portion of the contract shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. All subcontractors shall be considered the agents of the contractor and the latter shall be responsible for all work and material furnished and any indebtedness incurred by such agent. If any subcontractor fails to perform his work in a satisfactory manner, his subcontract may be terminated by the State Highway Engineer.

8.02 PROSECUTION OF WORK. The contractor shall begin the work to be performed under this contract within 10 days after the execution of the contract therefor, except as herein provided. The work shall be conducted in such a manner and with sufficient materials, equipment and labor as will insure its completion within the time set forth in the contract. If the contract be awarded at such season of the year as to make starting of work impracticable or impossible, work shall be started within 10 days of receipt of written notice from the engineer stating that conditions are such as to permit starting of operations. Should the prosecution of work for any reason be discontinued by the contractor, with the consent of the engineer, he shall notify the engineer at least 48 hours before again resuming operations.

The contractor shall notify the engineer, in writing 5 days in advance of the date he expects to start work and when he expects to begin important features of construction.

The place of starting work will be determined and designated by the engineer, and work will be progressively prosecuted at points as ordered by him.

Work during other than daylight hours on any class of work will not be permitted without the written consent of the engineer. Permission to perform night work may be rescinded by the engineer at any time when, in his opinion, satisfactory results are not being obtained.

8.03 LIMITATIONS OF OPERATIONS. The contractor shall not open up additional work to the prejudice or delay of work already started, nor shall he inconvenience traffic more than is necessary as determined by the engineer. At no time during the prosecution of the work shall more than 2 miles of roadway be under construction or obstructed to traffic without permission by the engineer. The final shaping of roadway ditches and borrow pits, the final finishing of earth graded roads and the fine grading of sub-grade and shoulders shall follow the rough grading as closely as possible. If forward grading operations are unduly extended beyond finishing operations,

they shall be suspended until all feasible finishing operations have been completed. Unless written permission is obtained from the engineer, placing of any surface course will not be permitted unless the contractor shall have at least 1 mile of completely finished grade in advance of the placing of such surface course.

The contractor shall begin work at such points as the engineer may direct and shall thereafter prosecute the work at such points and in such order as may be prescribed from time to time by the engineer.

8.04 CHARACTER OF WORKMEN AND EQUIPMENT. The contractor shall employ such superintendents, foremen and workmen as are careful and competent, and the engineer may demand the dismissal of any person or persons employed by the contractor in, about or upon the work, who shall misconduct himself or be incompetent or negligent in the due and proper performance of his or their duties, or who neglects or refuses to comply with the directions given; and such person or persons shall not be employed again thereon without the written consent of the engineer. The contractor shall furnish such adequate and proper equipment as is necessary for the proper prosecution of the work as specified.

When the work under the contract is to be paid for in whole or in part with funds granted or allotted to the State from the United States Government, no rental or depreciation will be allowed for any publicly owned equipment that may be used by the contractor in the performance of work done on a force account basis.

8.05 TEMPORARY SUSPENSION OF WORK. The engineer shall have the authority to suspend the work, wholly or in part, for such period or periods as he may deem necessary, due to unsuitable weather or to such other conditions as are considered unfavorable for the suitable prosecution or protection of the work, or for such time as is necessary on account of failure on the part of the contractor to carry out orders given or to perform any or all provisions of the contract. If it should become necessary to suspend work for an indefinite period, the contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way, and he shall take every precaution to prevent damage or deterioration of the work performed, provide suitable drainage of the roadway by opening ditches, shoulder drains, etc. The contractor shall not suspend the work without authority.

8.06 DETERMINATION AND EXTENSION OF CONTRACT TIME FOR COMPLETION. The date for completion will be determined by the engineer before proposals are called for, and will be specified in the proposal form and contract.

The contractor shall complete the work within the time limit specified, and elapsed time will be computed in calendar days. Requests for extension of contract time will be granted by the Commission only when it is clearly shown that, by a reasonable and possible increase in force and equipment, the contractor cannot complete the work within the time agreed upon. In planning his

organization, the contractor must make allowance for lost time due to unfavorable weather and other conditions and must provide such force of men and equipment as may reasonably be expected to complete the work within the time specified.

If satisfactory completion of the contract shall require extra or additional work the time allowed for performance shall be increased in the same ratio that the total cost of the extra or additional work shall bear to the total cost in the Bid Schedule.

If the contractor finds it impossible to complete the work on or before the time for completion specified in the contract, he may, not less than 10 days prior to said date, make written request to the Commission for an extension of time for completion. He shall set forth fully therein the reasons which he believes justify the granting of his request. If the Commission finds that the work was delayed because of conditions beyond the control of the contractor, they may grant an extension of time for completion as appears reasonable and proper.

The contractor shall not be assessed with liquidated damages nor the cost of engineering and inspection during any delay beyond the contract completion date caused by delay in awarding the contract, by inability to secure sufficient labor, by failure of the State to obtain right-of-way, by acts of God or the public enemy, acts of the State, fire, floods, epidemics, quarantine restrictions, strikes, boycotts, freight embargoes, or delays of subcontractors due to such causes; provided, that the contractor shall notify the engineer in writing of the causes of delay within 10 days from the beginning of any such delay, and the engineer shall ascertain the facts and the extent of the delay, and his findings of the facts thereon shall be final and conclusive.

NOTE: The Commission will consider a request by the Contractor for extension of time of completion of the contract on account of strikes, inability to secure sufficient laborers, time lost through delay in awarding the contract, or because of other unfavorable conditions clearly beyond the control of the contractor.

8.07 FAILURE TO COMPLETE THE WORK ON TIME. It is understood and agreed that time is the essence of the contract and that the work must be completed within the time specified in the proposal and contract. Should the contractor fail to complete the work within the time specified in the proposal and contract, or within any authorized extension thereof, and if the Commission does not terminate the right of the contractor to proceed, the contractor shall continue and complete the work; in which event, the actual damages for the delay will be impossible to determine and in lieu thereof the contractor shall pay to the Commission as fixed, agreed and liquidated damages for each calendar day that the work shall remain uncompleted beyond the completion date the sum set forth in the following schedule. The contractor shall be liable for the payment of the amount thereof, which amount shall be deducted from the final payment due the contractor under the contract.

SCHEDULE OF LIQUIDATED DAMAGES

Contract Price	Liquidated Damages
Less than $10,000	$10.00 per day
$10,000 and less than $25,000	$15.00 per day
$25,000 and less than $50,000	$25.00 per day
$50,000 and less than $100,000	$30.00 per day
$100,000 and less than $200,000	$35.00 per day
$200,000 and less than $300,000	$40.00 per day
$300,000 and over	$50.00 per day

8.08 ANNULMENT OF CONTRACT. If the contractor fails to comply with any of the requirements of the plans or specifications, or shall discontinue the prosecution of the work, or if the contractor shall become insolvent or bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of 6 days, or shall make an assignment for the benefit of creditors, or from any other cause whatsoever shall not carry on the work in an acceptable manner, the engineer shall upon receipt of such information give notice in writing to the contractor and his surety of such delay, neglect or default, specifying the same and if the contractor within a period of 3 days after such notice shall not proceed in accordance therewith, then the Commission shall, upon written certificate from the engineer of the fact of such delay, neglect or default and the contractor's failure to comply with such notice, have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said contractor to appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement with any other person or persons for the completion of said contract according to the terms and provisions thereof, or use such other methods as it may deem expedient for the completion of said contract in the specified manner. All costs and charges incurred by the Commission, together with the costs of completing the work under contract, shall be deducted from any moneys due or which may become due said contractor. In case the expense so incurred by the Commission shall be less than the sum which would have been payable under the contract, if it had been completed by said contractor, then the said contractor shall be entitled to receive the difference; and in case such expense shall exceed the sum which would have been payable under the contract, then the contractor and the surety shall be liable and shall pay to the State the amount of said excess.

8.09 TERMINATION OF CONTRACTOR'S RESPONSIBILITY. The contract shall be considered to have been completely fulfilled when all work has been completed and accepted by the Commission and the final estimate has been accepted by the contractor and paid. The contractor shall then be released from further obligation under the contract except as set forth in his Contract Bond.

SECTION 9

MEASUREMENT AND PAYMENT

9.01 MEASUREMENT OF QUANTITIES. The determination of quantities completed under the contract will be made by the engineer, based upon actual measurement of the work according to the United States standard measures. In computing volumes, the method of average end areas will be used for excavation and embankment. The area of surfacing to be paid for will be only the actual area covered by the entire surfacing or paving material within the lines designated or given, except that no deduction will be made for fixtures in the roadway or street of 4 square feet or less. Concrete and other similar structures will be measured, and volumes will be computed according to the neat lines shown on the plans or ordered by the engineer. Other quantities will be computed in units indicated in the proposal form according to well established engineering principles, and no local rules or customs at variance therewith will be considered.

9.02 SCOPE OF PAYMENTS. The contractor shall receive and accept the compensation as herein provided, in full payment for all work contemplated and embraced under the contract, also for all loss, damage or expense of whatever character arising out of the nature of the work or the prosecution thereof. The payment of any current or final estimate, or of any retained percentage shall in no way or in no degree prejudice or affect the obligation of the contractor to submit for final acceptance a completed improvement in accordance with the requirements of the plans, specifications and supplemental agreements.

The contractor shall promptly make payment for labor and material, at such times as claims therefor become due and payable, to all persons supplying said contractor therewith for the prosecution of the work contemplated herein, and he shall not permit any lien or claim to be filed or prosecuted against the State of Montana, or any officer, agent or employee thereof for or on account of any labor or material furnished.

9.03 PAYMENT AND COMPENSATION FOR ALTERED QUANTITIES. When alterations in plans or quantities of work not requiring supplemental agreements as hereinbefore provided, are ordered and performed, the contractor shall accept payment in full at the contract unit prices for the actual quantities of work done and no allowance will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the contractor resulting either directly from such alterations, or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefor, or from any other cause.

Concrete quantities shown in the bidding schedule may have been increased 10 per cent, roadway and structure excavation quantities 15 per cent, and base course surfacing quantities 10 per cent in order to cover possible overruns, but only accepted quantities actually entering into the final construction will be paid for.

9.04 EXTRA AND FORCE ACCOUNT WORK. Extra work as hereinbefore described under the sub-heading, "Scope of Work," shall be paid for either at agreed unit prices under the provisions of a "Supplemental Agreement," or on a "Force Account" basis, as shall have been agreed by the engineer and contractor before starting said work.

SUPPLEMENTAL AGREEMENT. When it has been agreed to perform certain extra work not contemplated in the original Proposal and Contract on the basis of agreed prices, a "Supplemental Agreement" will be prepared fully describing said extra work, including the approximate quantity as nearly as may be arrived at in advance of the performance of the work, and the agreed unit prices. This "Supplemental Agreement" shall be executed by both parties to the original contract, shall thereupon be considered a part of the contract, and payment for the work included therein shall be for the actual quantity performed at the agreed unit prices set forth therein. Extra work provided for by a "Supplemental Agreement" shall not be started until after the execution of the said agreement.

FORCE ACCOUNT WORK. Where extra work on a "Force Account basis has been ordered by the engineer in writing as provided under the sub-heading "Scope of Work," Section 4, it shall be paid for in the following manner:

(a) For all labor, teams and foremen in direct charge of the specific operation, the contractor shall receive actual direct payroll cost plus 15 per cent.

(b) For all materials used, the contractor shall receive the actual delivered cost of such materials as shown by original receipted bills, plus 10 per cent.

(c) For any machine-power tools or equipment, including fuel and lubricants, which it may be deemed necessary or desirable to use, the engineer shall allow the contractor a reasonable rental price, to be agreed upon in writing before such work is begun, for each and every hour or day that said tools or equipment are in use on such work and to which sum no percentage shall be added.

(d) For Workmen's Compnesation Insurance, Public Liability and Property Damage Insurance, and Premium on the Performance Bond, and such other expense as might be imposed on the contractor by Federal and State laws, the contractor shall receive the actual cost thereof chargeable to the force account work, to which no percentage shall be added. The contractor shall furnish satisfactory evidence of the rate or rates paid for insurance and bond.

(e) The compensation as herein provided shall be received by the contractor as payment in full for extra work done on a "force account" basis, and shall include superintendence, use of tools and equipment for which no rental is allowed, and profit. The contractor's record of extra work done on a "force account" basis shall be checked by the inspector at the end of each day and a copy of these records, signed by both the inspector and the contractor's representative, forwarded to the

engineer. All claims for extra work done on a "force account" basis shall be submitted on estimate forms furnished by the Commission, accompanied by the original Extra Work Order and receipted material and freight bills. Such claims shall be submitted to the engineer not later than the 10th day of the month following that in which the work was actually performed.

Payment for Extra Work, including Force Account Work, will be made as provided for in Paragraph 9.07.

9.05 OMITTED ITEMS. It is hereby provided that the engineer may order omitted from the contract items included in the original contract which may later be found unnecessary to the improvement, without thereby in any manner nullifying the contract or any of the other provisions thereof; provided however, that when the contractor has paid for material or incurred other expense in relation to any such item, before the elimination of same is ordered, he shall be reimbursed for his actual costs as evidenced by paid invoices, paid time checks and other similar evidence which may be demanded by the engineer to fully support the cost statement of the contractor. In no case of this sort shall any allowance be made for anticipated profits.

9.06 UNAUTHORIZED WORK. Work done without lines or grades being given, work done beyond the lines or grades shown on the plans or as given, except as herein provided, or any extra work done without written authority, will be considered as unauthorized and at the expense of the contractor and will be measured or paid for. Work so done may be ordered removed or replaced at the contractor's expense. In measuring quantities no allowance will be made for excavation or embankment in excess of that required by the sections shown on the plans unless such increase in quantity has been authorized in writing by the engineer.

9.07 PARTIAL PAYMENTS. The engineer shall make estimates in writing each working month of the materials in place complete and the amount of work performed, including "extra material" and "extra work," in accordance with the contract, during the preceding working month, and the value thereof figured at the unit prices contracted. Of the total amount so ascertained an amount equivalent to 10 per cent of the whole will be retained by the Commission until after the completion of the entire contract and the balance, or a sum equivalent to 90 per cent of the whole, will be certified by the Commission to the State Board of Examiners for payment, except when such balance amounts to less than $500.00. In case where the 90 per cent of the amount earned during any one month shall be less than $500.00, no payment will be made, except on final estimate, until the 90 per cent of the total amount earned since the last preceding payment is at least $500.00.

If the total amount of the retained percentage is greatly in excess of the value of the uncompleted and unaccepted portion of the contract, the Commission may, upon recommendation of the engineer and consent of the surety, allow the contractor a portion of this suspended payment, provided that the commission shall at all times

retain an amount sufficient to enable the State to complete the unaccepted or uncompleted work in the contract and liquidate unsatisfied claims. Partial payments shall not be evidence of acceptance of unsatisfactory work or material.

9.08 ACCEPTANCE AND FINAL PAYMENT. Whenever the contractor shall have completed the work in accordance with the terms of the contract, the engineer will make a final inspection of the work and upon completion of repairs, renewals or other work found to be necessary, if any, he will certify to completion and recommend to the State Highway Commission that they make final acceptance of the project, and such final acceptance will be made by the Commission at their next regular meeting after receipt of the certificate of completion and recommendation from the engineer. The statutory time for filing claims against the contractor and his surety shall date from the day final acceptance is made by the Commission. After certifying to completion, the engineer will prepare the final estimate, including therein the amount and value of each class of work performed, including "extra work" and "extra materials". He will transmit to the contractor a claim embodying said final estimate, and will notify the contractor and his surety of the acceptance of the contract. The accomplishment of the jurat on the final estimate claim by the contractor shall constitute full acceptance by him of the total amount shown as entire payment of the amount due him under the contract, and by this action the contractor shall be estopped from filing any claim whatever under the contract.

Upon return by the contractor of the accomplished final estimate claim, same shall be certified by the Commission to the State Board of Examiners for payment, and payment thereof shall constitute, together with previous partial payments, full satisfaction for the total amount due under the contract. Erroneous or over payments made by previous and partial payments shall be subject to correction in the final estimate.

DIVISION II

CONSTRUCTION DETAILS

PART I – EARTHWORK

DIVISION II

CONSTRUCTION DETAILS

PART I — EARTHWORK

SECTION 10
CLEARING

10.01 DESCRIPTION. This item shall consist of the removal and disposal of trees, stumps, brush, windfalls, logs, vegetation, and other objectionable matter occurring within the clearing limits, as hereinafter defined, or which interfere with excavation, embankment, or designated clear vision areas.

10.02 CONSTRUCTION METHODS. All areas of the right of way so designated on the plans or in the special provisions, and all areas between lines 5 feet outside of the grading limits for cuts, channels, ditches, material sites and sources, and within neat lines of fill areas, shall be cleared. If slopes are to be rounded, the clearing area shall extend to the outside limits of the slope rounding. Unless specifically designated to be saved, all trees, stumps, brush, windfalls, logs and other objectionable vegetation occurring within clearing limits shall be cut off and disposed of as hereinafter provided. All stumps within the right of way limits and all trees, the stumps of which are not to be grubbed, shall be cut not more than the diameter of the stump, and in any instance, not more than 12 inches above the ground.

Removal of live trees from within the area between the right of way lines and the clearing limits, as above defined, will not be required or permitted except as may be necessary to protect slopes or to add to the safety of the highway. However, all dead trees and windfalls shall be removed and underbrush and debris shall be cleaned from the entire width of the right of way. All stumps shall be cut off as prescribed in the preceding paragraph. Cleaning up of windfalls shall include the disposal of the uprooted stumps.

Timber having commercial value shall be cut into logs in accordance with established logging practice. Any loss from breakage due to unskilled or careless felling or handling may be charged back against the contractor. Logs shall be decked along the highway, free of cuts or fills, at points convenient for loading, and shall remain the property of the State. No National Forest timber may be cut or destroyed without first communicating with the National Forest officer responsible for the area concerned. All timber cut from the National Forest land shall remain the property of the United States, to be disposed of as the Forest officer may determine.

All trees shall be felled within the area to be cleared, and all brush, stumps, waste logs, limbs, tops, roots, duff, and other debris resulting from clearing, shall be placed in piles and burned, in such a manner as to be completely consumed. In case the burning is to precede the construction operations, the piles may be placed in the center of the right of way; otherwise the piles should be

placed in the most convenient place to the side of the right of way and beyond fill slopes, where they may be burned without damage to the surrounding forest cover. In no case will it be permissible merely to throw the refuse outside of the right of way or into streams or lakes. The material placed in piles shall be burned by the contractor, unless otherwise specified, at such time and in such manner as absolutely to prevent the fire from spreading to areas adjoining the right of way.

The contractor shall avoid, as far as practicable, injury to shrubbery, vines, plants, grasses and other vegetation growing on areas outside of the slope limits of excavations and embankments. The dragging, piling and burning of clearing debris, and work which may be injurious to vegetation, shall, insofar as is practicable, be confined to areas which carry no vegetation or which will necessarily be covered by embankments or disturbed by excavations. The provisions of this paragraph are not to be construed as relieving the contractor of the clearing away of dead vegetation, logs, stumps, limbs, sticks and other undesirable matter occurring on areas where live shrubbery, brush, trees, and other desirable vegetation are to be left in place.

All timber except that designated as having commercial value, and all slash and debris resulting from clearing and construction operations, shall be disposed of either by piling and burning or by any other method agreeable to the Forest officer, which removes it from the area, provided that piles made for later burning shall be located in places where burning will not injure uncut green timber growth of any size, and provided further that any burning undertaken shall be done only at such times, in such manner, and under such conditions or arrangements as may be prescribed beforehand by the Forest officer.

10.03 METHOD OF MEASUREMENT. The acreage to be paid for under this item, when included in the proposal form, shall be the number of acres and hundredths thereof actually cleared and accepted as complete, the boundaries of which shall have been established by the engineer prior to the beginning of work, either by setting stakes or other equivalent means. Appropriate deductions shall be made for cleared acreage of existing rights of way coincident with the right of way of the project under construction. Areas between the right of way lines and the clearing limits which require cleaning up and the disposal of underbrush, dead timber, logs, stumps, windfalls and other debris will not be measured as clearing, but shall be cleared by the contractor, and the cost of such clearing shall be absorbed in the unit prices bid.

10.04 BASIS OF PAYMENT. The acreage, as determined above, shall be paid for at the contract unit price per acre bid for "Clearing", which price and payment shall be full compensation for all labor, equipment, tools and incidentals necessary to complete the item.

SECTION 11

GRUBBING

11.01 DESCRIPTION. This item shall consist of the excavation, removal and disposal of roots, stumps, stubs, together with duff, matted roots, and buried debris from the grubbing limits, as hereinafter defined, unless otherwise specified on the plans or directed by the engineer.

11.02 CONSTRUCTION METHODS. All areas of the right of way so designated on the plans or in the special provisions, and all areas between lines 5 feet outside of the grading limits for cuts, channels, ditches and borrow pits, and all areas to be covered by embankments less than 3 feet in height, shall constitute the grubbing limits. All stumps, roots, logs or other timber more than 3 inches in diameter and all brush, matted roots and other debris within the grubbing limits not suitable for road foundation, shall be pulled or otherwise removed to a depth of not less than 12 inches below the original ground surface.

All material resulting from grubbing operations shall be piled and burned in accordance with Section 10.02; provided, however, that any such material not disposed of by burning shall be disposed of out of sight from the highway or neatly piled not less than 300 feet outside of the right of way, and written permits for such disposal shall be obtained by the contractor from the owner of the property upon which the material is placed and such permits or copies thereof shall be filed with the engineer.

Burning of grubbing debris shall normally be performed prior to grading operations; however, in the event burning permits cannot be secured from the proper authorities at the time contemplated for disposal of such debris, failure to secure such permits shall not be cause for delay in removal of grubbing debris from within areas affected by other operations. In such event the work under the item of "Grubbing" shall be construed to include placing of grubbing debris beyond the limits affected by other work until such time as burning permits can be secured, and re-handling and disposal of such debris done without delay to other work. Grubbing shall be kept at least 1000 feet ahead of grading operations. All depressions below the final surface of the ground, resulting from the grubbing operations, shall be backfilled with suitable material. Material secured from excavation operations for this backfilling will be paid for as "Roadway and Drainage Excavation," Section 13, and "Overhaul," Section 18.

11.03 METHOD OF MEASUREMENT. The acreage to be paid for under this item, when included in the proposal form, shall be the number of acres, and hundredths thereof, of land actually grubbed and accepted as complete, the boundaries of which shall have been established by the engineer prior to the beginning of the work, either by setting stakes or other equivalent means.

11.04 BASIS OF PAYMENT. The acreage, as determined above, shall be paid for at the contract unit price per acre bid for "Grubbing,"

which price and payment shall be full compensation for all labor, equipment, tools and incidentals necessary to complete the item.

SECTION 12

CLEARING AND GRUBBING

12.01 DESCRIPTION. This item shall consist of clearing the ground of all trees, brush and rubbish within the limits designated for clearing and for doing the necessary grubbing, as hereinbefore provided under Sections 10 and 11.

12.02 CONSTRUCTION METHODS. The work shall be done in accordance with Sections 10 and 11 of these specifications for "Clearing" and for "Grubbing."

12.03 METHOD OF MEASUREMENT. (a) When no quantity of "Clearing and Grubbing" is shown in the proposal, no measurements for the purpose of payment for this item shall be made.

(b) If an item is included in the proposal calling for a lump sum price for all "Clearing and Grubbing," then no measurements for purposes of payment shall be made other than those measurements necessary to determine whether or not the contractor has actually cleared and grubbed the full areas specified for clearing and grubbing.

12.04 BASIS OF PAYMENT. (a) When no quantities of "Clearing and Grubbing" are shown in the proposal, and no lump sum bid for "Clearing and Grubbing" is called for, then no allowance whatever shall be made for any "Clearing and Grubbing" done on the project, but all "Clearing and Grubbing" as required in these specifications shall be done at the contractor's own expense and shall be considered as subsidiary work pertaining to the items of roadway and drainage excavation and borrow.

(b) When a lump sum bid for all "Clearing and Grubbing" is called for in the proposal, the lump sum price so bid shall be full compensation for all necessary "Clearing and Grubbing," which work shall be done in accordance with Sections 10 and 11 of these specifications. It shall also include all clearing and grubbing from such areas as may be required for off-take ditches, channel changes, borrow pits, material sites and sources.

The lump sum price bid and payment thereof shall be full compensation for all labor, equipment, tools and incidentals necessary to complete the item.

SECTION 13

ROADWAY AND DRAINAGE EXCAVATION

13.01 DESCRIPTION. This item shall consist of performing all operations necessary to excavate earth and rock from the roadway prism; to construct, shape and slope embankments, subgrades, shoulders, gutters, ditches, intersections, approaches and private entrances, as directed and in the locations and to the elevations and forms planned; to backfill ditches and depressions; to remove and to make satisfactory disposal of all unsuitable and surplus materials occurring within the limits of the work; to build all approaches to structures; to furnish all equipment necessary for these operations; and to perform all incidental work of whatsoever nature which may be required to build the roadway and approaches to it. All material excavated shall be defined as "Unclassified Excavation", unless otherwise provided in the special provisions. The quantity of excavation shown in the proposal form will be 15 per cent in excess of the plan quantities in order to provide for possible overruns, but payment will be made only for the accepted yardage actually moved.

13.02 CONSTRUCTION METHODS. All suitable materials removed from the excavation shall be used as far as practicable in the formation of the embankment, subgrade, shoulders and at such other places as directed. No excavated material shall be wasted without permission, and when such material is to be wasted it shall be disposed of as directed by the engineer. No payment will be made for any excavated material which is used for purposes other than those designated. During the construction of the roadway, the roadbed shall be maintained in such a condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments shall be so constructed as to avoid damage to embankments by erosion.

If it is necessary in the prosecution of the work to interrupt existing surface drainage, sewers, or underdrainage, temporary drainage facilities shall be provided and maintained at the contractor's expense until permanent drainage facilities are completed. The contractor shall be responsible for, and shall take all necessary precautions to protect and preserve any and all existing tile drains, sewers, or other sub-surface drains, conduits and other underground structures or parts thereof, which may be affected by the operations in the contract, and which in the opinion of the engineer, may be properly continued in use without any change. The contractor shall, at his own expense, satisfactorily repair all damage to such facilities or structures which may result from any of his operations or from his negligence during the period the contract is in force.

Excavated rock shall be used in forming embankments wherever the depth of fill is sufficient to properly contain the rock removed by excavation, and shall be placed in accordance with directions given by the engineer. The engineer may permit the contractor to use excavated rock for purposes other than embankments, and in such case the contractor shall furnish and place, at his own expense, an amount of borrow equal to the deficiency caused by the rock being used elsewhere, if it is found necessary to borrow material to bring

any part of the road to grade.

The tops of excavation slopes shall be rounded as shown on the plans. Such rounding will be paid for at the price per cubic yard for roadway excavation and the price per station yard for overhaul for the quantities of material involved, and no additional allowance will be made therefor.

Where the roadway passes from cut to fill or from fill to cut, the contractor will be required to excavate all undesirable top soil between shoulder slopes to a depth of 18 inches below profile grade and to such a distance into the cut as the engineer may direct. The undesirable top soil, if not otherwise utilized, shall be placed in the bottom of the adjacent embankment at least 18 inches below the top of subgrade. If required for roadside improvement purposes, it shall be stockpiled and respread as required by the plans and special provisions.

When ordered by the engineer, material encountered in excavation suitable for backfill or road finishing material shall be saved and utilized for these purposes. When practicable, such material shall be hauled directly from excavation to its final position on the roadbed.

If handling the selected material directly from excavation to its final position is impracticable, selected material shall be excavated, piled at locations designated by the engineer, and later placed on the roadbed. Material so stockpiled will be paid for at the price per cubic yard for roadway excavation, for removing the material from excavation and placing in stockpiles, and again at the price per cubic yard for roadway excavation when the material is removed from stockpiles and placed in final position on the roadbed. Overhaul of such material will be paid for at the price per station yard.

In cases where fences within the right of way limits interfere with construction operations, the contractor shall take down such fences so as not to damage the material and deposit it in a neat manner at the edge of the right of way. The cost of removal of such fences shall be included in the unit price paid for excavation quantities.

Ditches shall be interpreted to mean roadway ditches, changes in channels of streams, ditches parallel to or adjacent to roadway, but beyond the limits of the roadway section as constructed, and inlet and outlet ditches to culverts and other structures, and shall also include "Furrow Ditches" as provided for in Section 27. All roots, stumps and other foreign matter in the sides and bottom of the ditch shall be cut to conform to the slope, grade and shape of the section shown. The contractor shall maintain and keep open and free from leaves, sticks and other debris, all ditches dug by him until final acceptance of the contract.

The contractor shall dispose of the excavated material as directed by the engineer. Suitable material excavated from all ditches and channel changes shall be placed in the embankments, or

used for widening the same, as shown on the plans or directed by the engineer. No excavation, or spoil, from a ditch shall be deposited or left within 3 feet of the edge of the ditch, unless otherwise shown on the plans or directed by the engineer in writing.

Night work shall not be permitted without the written permission of the engineer. Permission to perform night work may be rescinded at any time by the engineer, when in his judgement satisfactory results are not being accomplished.

13.03 METHOD OF MEASUREMENT. All accepted roadway and drainage excavation shall be measured in its original position by the method of average end areas, which measurements will include overbreakage or slides not attributable to carelessness of the contractor, and authorized excavation of solid rock below grade, also of soft and spongy spots below grade. The measurement shall include unavoidable overbreakage in solid rock excavation to an amount not to exceed in any half station of 50 feet, 10 per cent of the actual quantity required for the same half station within the lines shown on the plans. The end areas will be obtained by combining an accurate cross section of the original ground line with the theoretical or actual cross section of the completed work. Additional measurements will be taken to determine the volume of all overbreakage or slides not attributed to carelessness on the part of the contractor and for all authorized borrow pits.

13.04 BASIS OF PAYMENT. The yardage of roadway and drainage excavation, measured as provided above, shall be paid for at the contract unit price per cubic yard bid for "Unclassified Excavation", which price shall be full compensation for formation and compaction of embankments, disposal of surplus materials, preparation and completion of subgrade and shoulders, rounding of top and bottom of slopes and the furnishing of all equipment, tools, labor and incidentals necessary to complete the work.

SECTION 14

EXCAVATION FOR CULVERTS AND RETAINING WALLS

14.01 DESCRIPTION. This work shall consist of all excavation for foundations for culverts, retaining walls and other minor structures, and for excavation necessary for the removal of old culverts, and shall include the disposal of all material obtained from such excavation and backfilling to the level of the original ground.

14.02 CLASSIFICATION. All material excavated shall be unclassified and paid for as culvert excavation unless otherwise provided in the special provisions.

The excavation lines and bases of culverts shown on the plans shall be considered as approximate only, and they may be ordered in writing by the engineer to be placed at any elevation, or of any dimensions necessary to give a satisfactory foundation, and no additional compensation will be allowed for any such change except as provided under basis of payment.

Boulders, logs, or any unforseen obstacles encountered in excavating shall be removed and no additional compensation will be allowed because of difficulties found in removing such obstructions.

Culvert excavation shall include only that excavation which is removed below the final templet section of the roadway. If the contractor places culverts prior to the removal of the roadway excavation, he shall be paid culvert excavation only for that material which is removed below the final templet section.

14.03 BACKFILL. Backfill for culverts and retaining walls shall be placed and compacted as specified in Section 48.03 (f) of these specifications. Placing of embankment shall be in accordance with Section 15.01. Insofar as possible, backfill and embankment shall be kept symmetrical on all sides of structures and their component members to avoid displacement or unbalanced stresses.

14.04 METHODS OF MEASUREMENT. The yardage to be paid for shall be the yardage measured in original position of the material actually removed as hereinbefore prescribed, except that measurement of culvert excavation yardage shall be made to include quantities bounded by vertical planes 12 inches outside of the neat lines of the culvert, except where otherwise indicated on the plans or special provisions.

14.05 BASIS OF PAYMENT. Payment for all work prescribed under this item and measured as provided above shall be made at the contract unit price bid per cubic yard for culvert excavation, which price and payment shall be full compensation for furnishing all material, labor, equipment, tools and incidentals necessary to complete the work.

SECTION 15

EMBANKMENT

15.01 CONSTRUCTION METHODS. Embankments shall be constructed from suitable material taken from the designated excavation in conformity with the lines, grades and cross sections shown on the plans, designated by the engineer, or to such heights above grade and to such increased widths as the engineer may deem necessary to allow for foundation settlement, consolidation or compaction. Stumps, trees, rubbish, vegetation or other unsuitable materials shall not be placed in embankments. Sod mixed with satisfactory soil, and soil containing appreciable amounts of humus will be permitted in embankments if such material is uniformly distributed throughout the embankment.

Excavation frozen so as to preclude disposal of frozen material within the limits specified above, or under a blanket of snow, will be considered cause for shutting down grading operations. Whenever the surface of a cut or the site of an embankment is covered with snow or ice sufficiently deep to impair the stability of the work, the snow must be removed and deposited beyond the slope stakes at the contractor's own expense. Work of this nature shall be completed at least 100 feet in advance of the excavation and of the placing of the embankment.

When embankments are to be made on a hillside, or where new fill is to be made against existing embankments, or where fill is built one-half width at a time, the slopes of the original hillside, old or new fill, respectively, shall be cut into a depth of 12 inches as the work is brought up in layers. Material thus cut out shall be incorporated into the new fill at the contractor's expense.

Where embankments are to be made and compacted on original hillside, old or new fill, and end dumping is permitted, the slopes of the original ground, or fill, except in the case of rock slopes, shall be plowed or benched before filling is commenced.

If it should become necessary, because of weather or other conditions, to suspend grading operations the entire area worked upon shall be bladed until smooth, free of depressions and ruts, and crowned so that no water can collect or be impounded on the roadway.

Embankment material shall be placed and compacted in accordance with one of the following methods: (a) "Layer Placing Without Rolling"; (b) "Special Placing of Rock Material"; (c) "Layer Placing by Rolling (Tamping)". Unless otherwise specified in the special provisions or in the bid proposal form, Methods (a) or (b) will be used, according to the type of material encountered. The intent of these specifications is to secure an embankment of a homogeneous nature, with the component materials evenly distributed throughout, and all portions of the embankment uniformly and densely compacted.

Embankment placed adjacent to structures and for a distance of

10 feet therefrom, shall be brought up in equal layers on all sides of the timbers on trestles, or bulkheads, columns and small structures to prevent distortion of any of these parts. Areas inaccessible to tamping rollers or power rollers shall be compacted by hand or mechanical tampers or other means until the density conforms to that specified under "Layer Placing by Rolling"; provided, however, that for embankment, other than at structures, the compaction required shall not exceed that of the adjacent embankment, compacted in accordance with these specifications.

(a) Layer Placing Without Rolling. The material shall be placed in uniform, approximately horizontal layers not to exceed 8 inches in loose thickness of depth, for the entire width of the embankment and not less than 300 feet in length or for the entire length of the embankment. Each layer of embankment shall be completed, leveled and compacted before the succeeding layer is placed. On side-hill fills the end dumping method shall be permitted where the horizontal distance from original ground surface to embankment slope line in any cross section is less than 8 feet; provided, however, that the upper 10 feet of all embankments shall be placed in successive layers.

Material shall be spread and kept leveled by means of heavy blade graders, bulldozers or other approved equipment. Compacting equipment is to be kept on the embankment at all times and all material is to be spread, leveled and compacted as placed. The embankment surface is to be kept level and uniform at all times, except that where carry-all scrapers or similar units are used, the sides of embankments shall be constructed first and the center shall be brought up lower than the shoulders. Successive layers shall be compacted as evenly and densely as possible by routing the hauling and leveling equipment over the layers already in place, and by distributing such travel evenly over the entire width of the embankment.

Embankment material shall not be placed when the moisture incorporated in, or existing in, any layer causes excessive rutting by hauling equipment or when such moisture precludes proper compaction. In the case of filling in water or of filling over slopes too steep for the operation of construction and compacting equipment, the embankment may be constructed in one layer to the minimum elevation at which required equipment can be operated and above such elevation the embankment shall be placed in the specified layers and compacted as herein provided.

Embankments constructed to grade and cross section during the winter shall be refinished to grade and cross section after the frost is out of the ground and the embankment is in suitable condition for this work.

(b) Special Placing of Rock Material. Embankments formed of material containing by volume 25 per cent or more of rock larger than 6 inches in diameter shall be placed in layers of sufficient depth to contain the maximum size of rock present in the material; provided, however, that in no case shall the thickness of layers before compaction exceed 24 inches. Material containing rock shall

be deposited on the material being compacted and spread over the preceding layers by bulldozers or other methods satisfactory to the engineer, and the interstices shall be filled with finer material to form a dense compact mass. Even though the general thickness of layers is limited, the placing of individual rocks and boulders of a size not exceeding 48 inches in least dimension will be permitted; provided, they are carefully distributed and the interstices filled with finer material to form a dense compact mass. Hauling and spreading equipment shall be operated over the full width of each layer.

(c) Layer Placing by Rolling (Tamping). Where indicated on the plans, or in the proposal form or special provisions, embankments shall be constructed with extra compaction in accordance with the following requirements. Material shall be placed as required under sub-section 15.01 (a) above, except that the maximum thickness of layers shall contain only that amount of material which can be compacted to the specified density with the equipment used and in case the material contains less than 25 per cent of rock larger than 6 inches in greatest dimension then no layer shall exceed 8 inches in loose depth. Each layer of the embankment material shall be disced or harrowed sufficiently to break down clods over 6 inches in their greatest dimension, to thoroughly mix the various materials, and to secure a uniform moisture content. Each such layer shall be carefully leveled to a designated thickness before compacting so as to insure uniform and proper compaction.

Compaction shall be secured by the use of sheeps-foot or tamping rollers, or by three-wheel power rollers, as specified hereafter in Section 22.03 (a), depending upon the nature of the embankment material. Where the material is of such type as to require placing in layers not exceeding 8 inches in thickness, the layers shall be compacted by tamping rollers or by three-wheel power rollers. If the material is such as to require placing in layers of more than 8 inches in thickness, the layers shall be compacted by means of three-wheel power rollers. Where a layer is composed of all rock material, rolling will not be required.

Where embankments 3 feet or less in height are to be placed on soils having a relative compaction of less than 90 per cent as determined by A.A.S.H.O. Method T-99, the ground surface shall be scarified, watered and rolled before placing embankment material until a relative compaction of at least 90 per cent is reached in the upper 8 inches of the compacted soil. Should lightly compacted be encountered that extend to depths greater than 8 inches, the upper portion thereof, to a width equal to the width of the roadbed plus 1:1 supporting slopes, shall be removed to the depth ordered by the engineer, after which the ground surface shall be compacted until a relative compaction of 90 per cent is reached in the upper 8 inches. Material removed as herein provided shall be placed in embankment directly from excavation as directed by the engineer, or it may be placed alongside the trench and replaced therein after compaction operations have been completed within the excavated area. The material in the top 8 inches of the subgrade in cuts shall be compacted to the same density as that in adjoining embankments.

Full compensation for compacting the ground surface as above specified shall be considered as included in the price paid per cubic yard for roadway excavation. The removal of lightly compacted soil, and the placing of it in embankment at other locations or the replacing of the material in the trench after compaction operations have been completed will be paid for as roadway excavation. Should the contractor elect to place the excavated material alongside the trench and replace the material after compaction operations have been completed, no allowance in pay quantities will be made for replacing the material, full compensation for such work being considered as included in the price paid per cubic yard for removal of the material.

While embankment material is being placed in layers, the tamping or power rollers shall be operated continuously. The number of rollers required shall be proportional to the rate at which embankment material is being placed and shall be not less than one 3-wheel power roller or one 8-foot width of tamping roller for each 125 cubic yards, or fraction thereof, of material placed per hour. When several embankments, each of small area, are so isolated from each other that one roller cannot compact the areas satisfactorily, additional rollers shall be provided.

The required compaction shall be secured by rolling the layers as hereinbefore specified, and the amount of rolling or number of passes of the rollers required to secure compaction is dependent, within certain limits, upon the moisture contained in the material.

Embankment material which does not contain sufficient moisture to compact in accordance with the above requirement shall be sprinkled with water in accordance with the directions of the engineer, either during excavation or when being placed in embankment. Material containing an excess of moisture shall be permitted to dry to the proper consistency before being compacted.

Unless otherwise specified in the special provisions, each layer of embankment shall be compacted until the density of compacted material in the embankment shall be not less than the percentage of the minimum density shown in the following table in accordance with the minimum field compaction requirements of the A.A.S.H.O. Specification M-57.

Standard of Compaction or Maximum Density Obtained by A.A.S.H.O. Method T-99	Minimum Compaction Required, Per cent of Maximum Density
Lbs. per cu. ft.	
90 - 99.9	100
100 - 109.9	95
110 - 119.9	95
120 - 129.9	90
130 and above	90

Spreading and rolling equipment shall be powered or drawn by equipment with power adequate to insure efficient operation. In general, tractors drawing tamping rollers and tractors equipped with "dozer" units and used in spreading and compacting embankment

material shall be not less than 50 horsepower, manufacturer's rating. Three-wheel power rollers shall weigh not less than 10 tons and shall provide a compression on the rear wheels of not less than 325 pounds per linear inch of tire width. Tamping rollers shall conform to the requirements specified under "Rolling", Section 22.02 (b).

15.02 COMPENSATION. Embankment will not be measured or paid for directly. It shall be considered a necessary part of the work paid for as unclassified excavation, excavation for structures, or borrow as the case may be, and shall include all work incidental to depositing, drying if necessary, leveling and compacting the material. Where the addition of water is required, the same will be paid for at the unit price bid per thousand gallons of water in place. The cost of plowing hillsides or scarifying old roadbeds shall be included in the price bid for excavation.

SECTION 16

DISPOSAL OF SURPLUS MATERIAL

All surplus excavation and waste material shall be used to widen embankments uniformly or to flatten slopes, or shall be deposited in such other places and for such purposes as the engineer may direct. In no case shall material be deposited above the grade of the adjacent roadway unless directed in writing by the engineer. The contractor shall not borrow and waste without written application to, and written consent from, the engineer. Under no circumstances will payment be made for excavation beyond the established line of the roadway prism, or for borrow, when such excavation or borrow results from the method of borrow and waste, nor for overhaul not actually required by the design. The work described under this item will not be measured or paid for directly. It shall be considered a necessary part of the work for unclassified excavation or excavation for structures, as the case may be.

SECTION 17

BORROW

17.01 DESCRIPTION. This item shall consist of the excavation, and disposal as directed, of satisfactory material obtained from borrow pits designated, staked, and measured by the engineer. Borrow shall be used when sufficient quantities of suitable materials are not available from the roadway, structure and drainage excavation to properly form the embankment, subgrade, shoulders, and to complete the backfilling of structures. Where conditions are favorable, borrow pits in cuts to widen the roadway may be designated by the engineer.

17.02 CONSTRUCTION METHODS. The contractor shall notify the engineer sufficiently in advance of the opening of any borrow pit so that elevations and measurements of the existing ground surface may be taken. All borrow pits shall be neatly trimmed, and left in such shape as to permit of accurate measurement after the excavation is completed. Borrow pits adjacent to roadway sections shall be so excavated that no water will collect or stand therein and, if necessary, adequate means for drainage shall be provided.

17.03 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. Borrow shall be measured in its original position by the method of average end areas. The yardage so measured shall be paid for at the contract price per cubic yard bid for unclassified excavation; provided, however, that no payment whatever will be allowed the contractor for any material excavated from borrow pits or elsewhere prior to the staking out and cross sectioning of the work by the engineer.

SECTION 18

OVERHAUL

18.01 DESCRIPTION AND METHOD OF MEASUREMENT. When, in constructing embankments as directed, excavated or borrow material is hauled more than 500 feet, overhaul will be allowed on such material. The overhaul distance will be the distance between the centers of volume of the overhaul material in its original position and after placing, less 500 feet. The distance shall be measured along the shortest practicable route. The number of station yards or mile yards of overhaul shall be the product of the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance, in feet, divided by 100 if payment is made on a station yard basis, and divided by 5,280 if payment is made on a mile yard basis.

18.02 BASIS OF PAYMENT. Overhaul will be paid for at the unit price per station yard or per mile yard bid for overhaul, as called for on the proposal forms.

SECTION 19

SUBGRADE

19.01 DESCRIPTION. After the earthwork has been substantially completed and after all drains have been laid, the subgrade shall be brought to the lines, grades, and cross sections shown on the plans.

19.02 CONSTRUCTION METHODS. All soft and unstable material and other portions of the subgrade which will not compact readily shall be removed as directed. All boulders appearing in the earth excavation shall be removed or broken off to a depth of not less than 4 inches below the subgrade. All holes or depressions shall be filled with approved material and the subgrade brought to line and grade and compacted; this material shall be obtained as excavation or borrow and paid for as such unless otherwise directed in writing. All rock sections shall be brought to grade by depositing a satisfactory cushion material to the depth authorized by the engineer.

If the surface of an old stone or gravel roadbed conforms approximately to the surface of the finished subgrade at sections where reconstructed base course is not proposed, such sections shall be scarified superficially for the full width of the subgrade to a depth sufficient to eliminate all depressions and to permit of uniform reshaping.

All intersecting public highways shall be graded as shown on the plans or as directed by the engineer, and acceptable materials used on the surface so that a commodious, smooth-riding and satisfactory intersection shall be produced.

At all times ditches and drains along the subgrade shall be so maintained as to drain it effectively. When ruts of 2 inches or more in depth are formed the subgrade shall be brought to grade and if necessary be reshaped and rerolled. In no case shall any surface course or pavement be placed on a frozen or muddy subgrade. Until the subgrade has been checked and approved, no surface course or pavement shall be laid thereon.

19.03 COMPENSATION. Subgrade work shall not be measured or paid for directly, but shall be considered as part of the work included in the unit prices bid for unclassified excavation, culvert excavation or borrow, except cushion material for covering rock and boulder subgrade which will be paid for as hereinafter specified, in Section 24.04.

SECTION 20

SHOULDERS

20.01 DESCRIPTION. After the earthwork has been substantially completed, and after all drains have been laid, the shoulders shall be constructed of approved material to the elevation and shape shown on the plans, and after surface course or pavement is completed, dressed as directed to the full width of the roadbed.

20.02 CONSTRUCTION METHODS. Before any subgrade shall be approved the adjacent shoulders shall be constructed to the full width and at least to the level of the finished subgrade, but not necessarily to the final height and shape. In all cases where subgrade rolling is required, it shall be extended over the full width of the roadway. At all times construction shall be so carried on that the subgrade, shoulders and adjacent ditches will be effectively and completely drained. When the surface course or pavement is completed the shoulders shall be shaped and dressed, as directed, to the lines, elevations and cross section shown on the plans. This work shall be done in proper sequence with the surface course or pavement construction as directed.

20.03 BASIS OF PAYMENT. This work shall not be measured or paid for directly, but shall be considered as part of the work included in the unit prices bid for unclassified excavation and borrow or surfacing and pavement.

SECTION 21

WATERING

21.01 DESCRIPTION. This item shall consist of furnishing and applying water required in the compaction of embankments, subgrades, base courses and surface courses, in accordance with the requirements of these specifications.

21.02 CONSTRUCTION METHODS. Water, when required, shall be applied at the locations, in the amounts and during the hours as directed by the engineer. An adequate water supply shall be provided by the contractor. The equipment used for watering shall be of ample capacity and of such design as to assure uniform application of water and in the amounts directed by the engineer. When directed by the engineer, watering shall be done at night or at other times when evaporation loss will be at a minimum.

21.03 METHOD OF MEASUREMENT. The units of watering to be paid for shall be the number of 1000-gallon units of water as ordered, measured in the vehicle at the point of delivery on the road or measured by a meter of an approved type, furnished and installed by, and at the expense of, the contractor.

21.04 BASIS OF PAYMENT. The accepted quantities of this item shall be paid for at the contract unit price bid per 1000-gallon unit, which price and payment shall be full compensation for furnishing, hauling and applying, and for all labor, equipment, tools and incidentals necessary to complete the item, except furnishing water plants for the project, which shall be paid for at the lump sum bid for "Providing and Maintaining Water Plant." No payment shall be made for the latter unless installation is authorized in writing by the engineer.

When the bid schedule does not contain an estimated quantity for the above pay item, the performance of this item including "Providing and Maintaining Water Plant" shall be considered as a subsidiary obligation of the contractor covered under pay items involved in the contract and no allowance shall be made for providing or maintaining a water plant.

Unless otherwise stated in the special provisions payment will be made for water used in the compaction of embankment and subgrade and of base and surface courses. Watering fine grade for pavement will not be paid for separately and the cost thereof shall be considered as included in the contract prices for pavement items.

The State reserves the right to increase, decrease, or to omit, all or any part of the estimated amount of water to be used and no additional compensation will be allowed by reason of such increase or decrease.

SECTION 22

ROLLING

22.01 DESCRIPTION. This item shall consist of the compaction of embankments, subgrade, shoulders, base and surface courses in accordance with these specifications.

22.02 EQUIPMENT. (a) Power Rollers. Power rollers shall be of the self-propelled, 3-wheel or tandem type and of the weight as required under the specifications for the type of work being performed. The roller shall be equipped with such cleaning devices as necessary to prevent adhesion of materials to the wheels.

(b) Tamping Rollers. Tamping rollers shall consist of metal rollers, drums or shells, surmounted by metal studs with tamping feet projecting not less than 7 inches from the surface of the roller, drum, or shell. Tamping feet shall be spaced not less than 6 inches or more than 10 inches, measured from center to center in any direction and the cross sectional area of each tamping foot, measured perpendicularly to the axis of the stud shall not be less than 4 nor more than 12 square inches. The roller shall be provided with cleaning teeth to provide self-cleaning. The weight of the tamping roller shall be such that the load on each tamping foot shall be not less than 150 pounds per square inch of cross sectional area. The load per tamping foot will be determined by dividing the total weight of the roller by the number of tamping feet in one row parallel to or approximately parallel to the axis of the roller. The tamping roller shall be drawn by a suitable crawler-type tractor with adequate power for its efficient operation. Each tamping roller shall consist of two sections and the length of each section shall be not less than 4 feet.

(c) Pneumatic-Tired Rollers. Pneumatic-tired rollers shall be of the two-axle type, having a width of not less than 4 feet nor greater than 6 feet and equipped with pneumatic tires of equal size and diameter, with treads satisfactory to the engineer. The space between sidewalls of adjacent tires shall not be greater than 5 inches and the rear tires shall be staggered with relation to the front tires. The tires shall be uniformly inflated and the air pressure in the several tires shall not vary from each other more than 5 pounds per square inch. Axles shall be mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. The pneumatic-tired roller, under working conditions, unless otherwise specified, shall have a minimum weight of 160 pounds per inch width of tire tread. It shall be drawn by either suitable tractor or truck of adequate tractive power.

22.03 CONSTRUCTION METHODS. Rolling shall be performed when and as directed by the engineer and shall be done in accordance with the specifications covering the particular type of work involved. In general, each layer of a surface course placed upon the roadway, or each layer of embankment, where "Layer Placing by Rolling (Tamping)" is required, shall be rolled and compacted before the succeeding course or layer is placed. Rolling shall be extended completely across the roadway, commencing at the sides and progressing toward

the center, overlapping at each succeeding passage by approximately one-half the width of the roller unit. On super-elevated curves, rolling shall begin at the low side and progress toward the high side. Rolling shall be continued until, in the judgment of the engineer, sufficient compaction has been secured. The amount of rolling on any surface course shall be controlled exclusively by the engineer. The rollers, unless otherwise directed, shall operate at a speed between two and three miles per hour.

In general the type of roller specified will conform to the following requirements. Wherever in these specifications the weights of rollers are specified, compliance therewith shall be on the basis of the manufacturer's ratings. Weighting of rollers to make them meet weight specifications will not be permitted, except as provided under Section 22.02 (c) above.

(a) Compaction of Embankment. Where material is of such nature as to require "Layer Placing by Rolling (Tamping)" as provided in Section 15.01 (c), tamping rollers, or three-wheel power rollers weighing not less than 10 tons and providing a compression on the rear wheels of not less than 325 pounds per lineal inch of the width, shall be used.

Where material is of such nature as to require placing in layers between 8 inches and 24 inches in thickness, the layers shall be compacted by three-wheel power rollers weighing not less than 10 tons.

(b) Compaction of Subgrade and Gravel Courses. Compaction of subgrade and of gravel base and surface courses shall be done by self-propelled three-wheeled power rollers weighing not less than 8 tons. Pneumatic-tired rollers may be used at the discretion of the engineer.

(c) Compaction of Bituminous Courses. Compaction of bituminous surfaces shall be done by self-propelled rollers weighing at least 8 tons. Either 3-wheel or tandem rollers may be used for the initial compaction but the final rolling shall be done with a tandem roller. Rolling of cover material used in sealing operations shall be done with a tandem roller weighing at least 6 tons, but not over 10 tons.

22.04 METHOD OF MEASUREMENT. Rolling units shall be determined on the basis of a compacting width of roller of 6 feet and the hours of time actually consumed in rolling. The rolling units shall be computed, therefore, by multiplying the time in hours actually consumed in rolling by the effective rolling width of the roller, in feet, and dividing the product by 6. Time consumed in servicing or repairing the roller or in moving to and from the point where the work is to be done, shall not be measured or paid for.

22.05 BASIS OF PAYMENT. The accepted quantities of this item will be paid for at the contract unit price bid per "rolling-unit" for rolling, as called for in the proposal form, which price and payment, except as otherwise expressly provided, shall be full compensation for all materials, labor, equipment, tools and incidentals necessary to complete the work.

Unless otherwise stated in the specifications or special pro-

visions, rolling required for compaction of embankments, and all other compaction required in connection with grading operations and for compaction of plant mixed surfacing will not be paid for separately, but shall be considered as included in the bid price for the various items entering into the work.

SECTION 23

FINISHING EARTH-GRADED ROADS

23.01 DESCRIPTION. This item shall consist of the final finishing of the roadbed where an earth-graded road without surfacing other than earth or select material is proposed, or in preparation for the placing of sub-base, base, or surface courses. The work shall consist of shaping and dressing the roadbed to conform to the lines, grades, and typical cross sections shown on the plans, or staked by the engineer.

23.02 CONSTRUCTION METHODS. After all earthwerk has been substantially completed, all structures are complete, and all drains laid, the entire surface of the roadbed shall receive a finish shaping with a grading machine, supplemented by hand work where necessary to secure a smooth surface and uniform cross section. All rock sections and all other sections where the natural material is not deemed suitable by the engineer shall be brought to grade by depositing to the depth authorized by the engineer a satisfactory cushion of selected material. The entire roadbed shall be brought to the final elevation and shape indicated on the plans and dressed as directed by the engineer. No roots, sod, or other deleterious matter shall be left within the top 4 inches of the finished road surface. Oversize material, either loose or partly buried, that will not pass a 3-inch circular screen, shall be removed from the entire surface of the roadbed and shall be disposed of as directed. The finished grade shall not deviate more than one-tenth foot at any point from the staked elevation, and, provided further, that the sum of the deviations from true grade of any two points not more than 30 feet apart shall not exceed one-tenth foot.

In order to secure a smooth, even surface to the finished grade, the contractor building the grade shall provide and use a grader weighing not less than 8,000 pounds, with sufficient tractor power for its efficient operations, or a motor grader of an approved design weighing not less than 14,000 pounds.

23.03 BASIS OF PAYMENT. Cost of finishing shall be included in the unit prices bid for excavation, except cushion material which will be paid for as hereinafter specified in Section 24.04.

SECTION 24

CUSHION MATERIAL

24.01 DESCRIPTION. This item shall consist of the placing of a satisfactory cushion of gravel material upon the sections of the project where the subgrade is composed of rock or boulders.

24.02 MATERIAL AND METHOD OF CONSTRUCTION. The material used shall conform to the requirements for gravel sub-base except that it shall contain no stones which will not pass a screen having 3-inch circular openings. The material shall be obtained from pits designated by the engineer and approved by the Testing Laboratory, and shall be hauled and spread to the depth shown on the plans or as designated by the engineer. Where the material is hauled for a distance in excess of 1 mile, overhaul will be allowed on such material.

24.03 METHOD OF MEASUREMENT. Cushion material will be measured by the cubic yard, truck measurement at the point of delivery on the roadway, and, unless otherwise specified, haul will be measured by the mile, the distance for which overhaul is allowed being the distance, in miles, between the centers of volume of the overhauled material in its original position and after placing, less one mile. The number of cubic yard miles of overhaul shall be the product of the volume of the overhauled material, measured as above specified, in cubic yards, by the overhaul distance in miles.

24.04 BASIS OF PAYMENT. Payment will be made for the following items: Cushion material, including all haul within one mile, per cubic yard; overhaul on cushion material, hauled over one mile, per cubic yard mile.

These bid prices and payments shall be full compensation for furnishing, loading, hauling and spreading all material, and for all equipment, tools, labor, and incidentals necessary to complete the work.

SECTION 25

FINE GRADING SUBGRADE AND SHOULDERS

25.01 DESCRIPTION. This item shall consist of the preparation and reconditioning of a previously graded roadway, for immediate placement of base course, surface courses or pavement, in conformity with the lines, grades and typical cross section shown on the plans or staked by the engineer.

25.02 CONSTRUCTION METHODS. (a) General Requirements. All slide material shall be removed from the ditches, and those portions of the existing roadway, including parking areas, so directed by the engineer, shall be scarified, bladed and shaped to conform accurately to the line, grade and cross section shown on the plans or staked by the engineer. Any high places in the roadbed shall be cut to grade and the resulting surplus material used to bring low sections up to grade or to widen embankments, or otherwise disposed of as directed by the engineer. Should there remain any depressions or narrow embankments, sufficient approved suitable material shall be obtained and placed to bring the surface of the roadway to the exact lines, grades and cross section established. The roadbed shall then be rebladed and reshaped. At intersections, the roadbed of the side road shall be treated similarly for the distance ordered by the engineer or as governed by the grading performed, and so as to provide for proper joining of the proposed and existing riding surfaces. The roadbed shall be compacted and all work shall be performed that may be necessary to produce a completed and acceptable foundation for the placement of the base course, surface course or pavement.

(b) Special Compacting. Where indicated on the plans, the subgrade shall be stabilized by special compaction in accordance with the following requirements:

After the subgrade has been shaped to line, grade and cross section, it shall be thoroughly compacted by rolling with a power roller weighing not less than 8 tons. If necessary, water shall be applied uniformly to the subgrade prior to and during the rolling, when and in the amounts directed by the engineer. Any low spots that develop during the rolling shall be brought to grade with additional material and re-rolled.

25.03 METHOD OF MEASUREMENT. The mileage of fine grading to be paid for, subject to 25.04 below, shall be the number of miles of roadway, measured along the center line thereof, fine graded to the required width and accepted.

25.04 BASIS OF PAYMENT. When the bid schedule contains an estimated quantity for "Fine Grading Subgrade and Shoulders", the number of miles, determined as provided for above, shall be paid for at the contract unit price bid per mile for "Fine Grading Subgrade and Shoulders", which price and payment shall constitute full compensation for shaping, dressing, and compacting the subgrade and shoulders, and for all labor, equipment, tools and incidentals necessary to complete the item, provided that excavation below a point 0.3 foot under

the existing roadbed surface, removal of all slides in excess of 5 cubic yards per station, and additional borrow material required to bring the roadway to the finished section, shall be paid for at the contract unit price bid for "Unclassified Excavation", "Borrow" and "Overhaul", as the case may be, and provided further that where the bid schedule contains an estimated quantity for "Watering of Subgrade", any watering required under special compacting shall be paid for as provided under Section 21.

Except where the plans expressly provide for this item and the bid schedule and contract contain a bid price for "Fine Grading Subgrade and Shoulders", any work required under this item will not be paid for directly but shall be considered as necessary and subsidiary work covered under the contract price for the proposed surface course or pavement.

SECTION 26

OBLITERATION OF OLD ROADWAY

26.01 DESCRIPTION. This item shall consist of the obliteration, in accordance with these specifications, of such portions of abandoned roadways as are shown on the plans or designated by the engineer for obliteration and shall include the appropriate grading, scarifying, plowing and harrowing of such areas of the old roadway as directed.

26.02 CONSTRUCTION METHODS. After the old road is no longer needed for traffic, the old ditches shall be filled and the roadway graded, either to approximately restore the original contour of the ground or to produce a contour that will merge with the contour of the adjoining land. Where feasible, the old ditches may be filled by blading the existing surfacing material into them and covering it with suitable soil. Old structures, including guard rail, not included in other bid items for removing structures, shall be broken down and buried or removed, as directed. All material with salvage value shall be carefully removed and neatly piled to avoid damage.

After the rough grading is completed, the area of the old road surfacing shall be scarified or plowed to effectively mix the remaining metal with earth and the entire area of the old roadway shall be harrowed and smoothed. The entire area shall be left with a smooth surface, having rounded slopes level enough to permit cultivation.

26.03 METHOD OF MEASUREMENT. The length of old roadway obliterated to be paid for shall be the number of stations of 100 feet, and fractions thereof, of roadway, measured along the centerline thereof, obliterated as required and accepted.

26.04 BASIS OF PAYMENT. When the bid schedule contains an estimated quantity for "Obliteration of Old Roadway", the number of stations, determined as provided above, shall be paid for at the contract unit price per station bid for "Obliteration of Old Roadway", which price and payment shall be full compensation for all material, labor, equipment, tools and incidentals necessary to complete this item, except as provided in (a) and (b) below.

(a) Material obtained from the old roadway and used in construction of the new roadway shall be paid for under "Borrow" and "Overhaul", as the case may be.

(b) When the bid schedule does not contain an estimated quantity for "Obliteration of Old Roadway", the length of this item shall not be paid for directly but shall be considered as a subsidiary part of the obligation of the contractor, covered under other contract items.

SECTION 27

FURROW DITCHES

27.01 DESCRIPTION. This item shall consist of the construction of furrow ditches in accordance with these specifications and in conformity with the locations and lines shown on the plans or as directed by the engineer. Furrow ditches shall be constructed above cut slopes for the purpose of intercepting surface drainage.

27.02 CONSTRUCTION METHODS. Furrow ditches shall be formed by grader, or other methods, along the lines indicated following the natural slope of the ground. They shall be cleaned out by hand shovel work, or some other suitable method, throwing all loose material on the downshill side so that the bottom of the finished ditch shall be approximately 18 inches below the crest of the loose material piled on the downhill side. Hand finish will not be required, but the flow lines shall be in satisfactory shape to provide drainage without overflow.

27.03 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. The yardage moved in constructing furrow ditches shall be measured and paid for as "Roadway and Drainage Excavation," as provided for in Section 13 of these specifications, which price and payment shall be full compensation for excavation of the furrow ditches and the forming of banks, and for all labor, equipment, tools and incidentals necessary to complete the item.

DIVISION II

CONSTRUCTION DETAILS

PART II - SUBBASE, BASE AND SURFACE COURSES

DIVISION II

CONSTRUCTION DETAILS

Part II--Subbase, Base and Surface Courses

SECTION 28

Rock or Gravel Subbase and Base Courses

28.1 Selected Borrow Base Course

28.1-01 DESCRIPTION. This item shall consist of a foundation course composed of one or more layers of selected borrow material such as pit run gravel, talus rock, disintegrated granite, sand, shale, scoria or other similar materials obtained from sources designated on the plans or in the special provisions, or authorized sources supplementary thereto, selected under the direction of the engineer.

28.1-02 MATERIAL. The material shall conform in maximum size and grading to the following limits:

Passing a screen with 4" square openings	100%
Passing a No. 4 sieve	25 to 50%
Passing a No. 200 sieve, not more than	15%

The material passing the No. 40 sieve shall not have a liquid limit in excess of 25 nor a plasticity index in excess of 6, provided however, that material having a zero plasticity index may have a liquid limit of not to exceed 30.

28.1-03 CONSTRUCTION METHODS. Immediately prior to the placing of a selected borrow base course, the surface of the grade shall be bladed smooth and shaped to the cross section as shown on the plans. All holes, ruts, defects or soft places occurring in the subgrade because of traffic or haul over same, or for any other cause, shall be corrected before surfacing materials are placed on the roadway. No sub-base course shall be placed upon wet or muddy subgrade unless otherwise directed by the engineer. At least one mile of finished and accepted earth graded road shall be completed in advance of the placing of any sub-base course.

The subgrade shall be compacted by rolling as directed by the engineer. Where required and directed by the engineer, the roadbed shall be thoroughly watered with an approved type of watering device prior to and during rolling operations. The amount of water to be used shall be determined by the engineer.

The material in any base course shall be mixed and placed in horizontal layers of not more than 6 inches loose thickness. The depositing and spreading of the material on the prepared subgrade, or on a completed base course layer, shall commence at the point farthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer and without segregation of

size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer will have the required thickness. Spreading shall be from dump boards, spreader boxes, or moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required, the construction procedure described shall apply to each layer. Each layer of each base course shall be bladed smooth and thoroughly compacted by rolling, supplemented by water, if required, before the succeeding layer is placed.

If the material in the pit from which the base is obtained contains more than 15 percent of oversize material, the oversize material shall be removed by passing the gravel through a screen at the pit. If the pit run material contains less than 15 percent oversize material, screening will not be required providing the contractor forks or rakes off all oversize material which protrudes above the grade line of the finished base course section and disposes of this oversize material as directed by the engineer.

Spreading, watering processing and compacting shall be done in accordance with Sections 29.02 to 29.04 of these specifications.

28.1-04 METHOD OF MEASUREMENT. Selected borrow base course material shall be measured by the cubic yard loose measurement in the vehicle at the point of delivery on the road, or by the ton, as may be designated in the proposal form. If measured by the cubic yard, a deduction shall be made for the amount of oversize material which it may be necessary to remove from the roadway. If measured by the ton, the requirements as set forth under Section 29.07 (a) shall apply.

Measurement of watering and rolling shall be made in accordance with Sections 21 and 22 of these specifications.

28.1-05 BASIS OF PAYMENT. The yardage of selected borrow base course material determined as provided above shall be paid for at the contract unit price bid per ton or per cubic yard complete in place, which price and payment shall be full compensation for furnishing, loading, hauling, spreading, shaping and for all equipment, tools, labor and incidentals necessary to complete the work.

Watering and rolling will be paid for as provided in Section 21 and 22 of these specifications.

28.2 Base Course

28.2-01 DESCRIPTION. This item shall consist of one or more courses of crushed gravel or stone base course material, constructed on the prepared subgrade or previously placed selected borrow base course in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross sections shown on the plans or designated by the engineer.

28.2-02 MATERIAL. Crushed gravel or crushed stone base course material (classes 1, 2 and 3) shall consist of hard, durable particles of fragments of stone or gravel crushed to required size, and

a filler of sand or other finely divided mineral matter. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate and that portion passing a No. 4 sieve shall be known as filler. When produced from gravel, not less than 50 per cent by weight of the coarse aggregate particles shall be particles having at least one fractured face, and if necessary to meet this requirement or to eliminate an excess of filler, the gravel shall be screened before crushing. The composite base course material shall be free from vegetable matter and lumps or balls of clay and shall meet the requirements for one of the following classes, whichever is called for in the bid schedule.

(A) Class 1 Material (Coarse Graded). Class 1 material shall meet the requirements for one of the gradings given in Table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1 - Requirements for Grading

Sieve Designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A-1	Grading B-1	Grading C-1	Grading D-1
3 inch	100	---	---	---
2 inch	---	100	---	---
1½ inch	---	---	100	---
1 inch	35-65	50-80	---	100
No. 4	10-30	15-35	20-40	25-45
No. 200, less than	---.	---	10	10

(B) Class 2 Material (Intermediate Graded). Class 2 material shall meet the requirements for one of the gradings given in Table 2, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 2 - Requirements for Grading

Sieve Designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A-2	Grading B-2	Grading C-2	Grading D-2
3 inch	100	---	---	---
2 inch	---	100	---	---
1½ inch	---	---	100	---
1 inch	45-75	50-80	---	100
No. 4	15-45	20-50	25-55	30-60
No. 10	---	---	---	20-50
No. 200 less than	10	12	12	12

The amount of the fraction of Class 2 material passing the No. 200 sieve shall be less than one-half of the fraction passing the No. 40 sieve.

That portion of the filler, including blended filler, for Class 2 material, passing a No. 40 sieve shall have a liquid limit of not more than 30 and a plasticity index of not more than 6, as determined by A.A.S.H.O. Methods T 89 and T 91, respectively.

Coarse aggregate for Class 2 material shall have a per cent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T 96 (Los Angeles Rattler Test).

(C) Class 3 Material (Stabilized). Class 3 material shall meet the requirements for one of the gradings given in Table 3, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 3 - Requirements for Grading

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A-3	Grading B-3	Grading C-3	Grading D-3
3 inch	100	---	---	---
2 inch	65-100	100	---	---
1½ inch	---	70-100	100	---
1 inch	45-75	55-85	70-100	100
3/4 inch	---	50-80	60-90	70-100
3/8 inch	30-60	40-70	45-75	50-80
No. 4	25-50	30-60	30-60	35-65
No. 10	20-40	20-50	20-50	25-50
No. 40	10-25	10-30	10-30	15-30
No. 200	3-10	5-15	5-15	5-15

The gradations shown for Class 1, 2 and 3 material represent the extreme limits which shall determine the suitability of aggregate for use. The final gradation decided on within the limits designated in the tables shall be uniformly graded from coarse to fine and shall not vary from the low limits on one screen to the high limits on the adjacent screen, or vice versa.

The engineer may, when necessary to obtain a desired and uniform mixture, fix the maximum percent of the mineral aggregate passing the No. 4 sieve within the specified limits and the contractor will not be allowed any claim for payment of cost for rejection of fines to conform to such maximum limits.

The amount of the fraction of Class 3 material passing the No. 200 sieve shall be less than one-half that of the fraction passing the No. 40 sieve.

That portion of the filler, including blended filler, for Class 3 material passing a No. 40 sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 6, as determined by A.A.S.H.O. Methods T-89 and T-91, respectively.

Coarse aggregate for Class 3 material shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Filler for Blending. If filler in addition to that naturally present in the base course material is necessary for meeting the grading requirements or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the screening and crushing plant or on the road as specified in Section 32. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from hard lumps and shall not contain more than 15 percent of material retained on a No. 4 sieve.

28.2-03 PREPARATION OF SUBGRADE. Before placing base material, the subgrade shall be brought to a uniform cross section and grade conforming to the plans. Soft or spongy material shall be removed from the subgrade, the holes backfilled with approved granular material and the entire subgrade firmly compacted by rolling if so directed by the engineer.

The roller or rollers used shall be either a self-propelled 3-wheel roller, weighing not less than 8 tons or a sheep's foot tamping roller of an approved design. Pneumatic tired rollers may be used if approved by the engineer.

Rolling shall commence at the sides and progress toward the center. No less than three complete passages of a roller of any type shall be required and rolling shall be continued until the surface of the roadbed is smooth and unyielding.

When required and directed by the engineer, the roadbed shall be thoroughly watered with an approved type watering device prior to and during rolling operations. The amount of water to be used shall be determined by the engineer. Where the roadway has been under traffic and the surface has been to some extent compacted or is in such hardened condition that it will not permit the entrance of water nor yield under the rollers, the roadbed shall be scarified to a depth of not less than 4 inches and shall be bladed true to cross section with a heavy blade grader prior to the commencing of watering and rolling operations. Provided, however, that on those sections which are satisfactorily compacted and are smooth and true to line and grade, the engineer may omit the required scarifying, watering and rolling.

NOTE: In order to save repetition it shall be understood that Sections 29.01 to 29.08, inclusive, apply to the method of placing, measurement and payment for base course surfacing, top course surfacing (type "A"), cushion course and top course surfacing (type "B") and all items pertaining thereto.

SECTION 29

ROCK OR GRAVEL SURFACE COURSES

29.1 Top Course (Type A)

29.1-01 DESCRIPTION. This item shall consist of a course or courses of crushed gravel or stone and filler placed on the roadway in accordance with these specifications and in conformity with the lines, grades and typical section shown on the plans. In general it will serve as the aggregate for the cushion course between the base and the bituminous material and for the aggregate to be incorporated into the bituminous surface.

29.1-02 MATERIAL. Aggregate for gradings A, B, C, D and F shall consist of coarse aggregate or gravel, crushed to size as necessary, or crushed stone, in either case composed of hard durable pebbles or stone fragments, and a filler of finely crushed stone, sand or other finely divided mineral matter. Aggregate for grading E shall consist of fine gravel and sand, disintegrated granite, or other similar granular materials. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. The composite material shall meet the requirements for one of the gradings given in Table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

Table 1 - Requirements for grading of Aggregate

Sieve Designation	Grading A	Grading B	Grading C	Grading D	Grading E	Grading F
1 inch	100	100	100	100	100	---
3/4 inch	75-100	75-100	85-100	85-100	85-100	100
No. 4	30- 45	40- 60	45- 65	50- 70	60- 95	40-65
No. 10	20- 35	25- 45	30- 50	35- 55	45- 80	30-55
No. 40	---	---	---	---	---	15-35
No. 200	2- 7	3- 8	5- 10	5- 12	5- 15	4-10

The above gradations represent the extreme limits which shall determine the suitability of aggregate for use. The final graduation decided on within the limits designated in the tables shall be uniformly graded from coarse to fine, and shall not vary from the low limits on one screen to the high limits on the adjacent screen, or vice versa.

The engineer may, when necessary to obtain a desired and uniform mixture, fix the maximum percent of the mineral aggregate passing the No. 4 sieve within the specified limits and the contractor will not be allowed any compensation for cost incurred in the rejection of fines to conform to such maximum limits.

Aggregate shall be so graded within the limits given in Table 1 that at least 10 percent of the total aggregate shall pass a No. 4 sieve and be retained on a No. 10 sieve. The amount of the fraction passing the No. 200 sieve shall be less than one-half the portion passing the No. 40 sieve. No intermediate sizes of aggregate shall

be removed for use in the seal coat or for other purposes without the written consent of the engineer.

When one of the gradings A, B, C, D or F is specified, the coarse aggregate shall have a percent of wear of not more than 40 at 500 revolutions, as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

For all gradings, that portion of the filler, including any blended filler, passing a No. 40 sieve shall have a liquid limit of not more than 30 and a plasticity index of not more than 6, as determined by A.A.S.H.O. Methods T 89 and T 91, respectively.

The composite aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films of clay or other matter that will prevent thorough coating with bituminous material. The aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work will not slough off upon contact with water. The bituminized aggregate shall have a swell of not more than 1.5 percent, as determined by method "A" of A.A.S.H.O. Method T-101.

29.2 TOP COURSE (Type B)

29.2-01 DESCRIPTION. This item shall consist of one or more courses composed of crushed rock or gravel constructed on the prepared base in accordance with these specifications and in conformity with the lines, grades and thickness shown on the plans and shall constitute the wearing course of the finished roadway without the addition of bituminous materials or other stabilizing agencies.

29.2-02 MATERIAL. The material for this work shall be crushed from rock or gravel having a loss of not to exceed 40 percent when subjected to 500 revolutions of the Los Angeles abrasion machine and shall be uniform in quality and grading. When tested by means of laboratory sieves it shall, including any binder which may have been added, meet the following requirements.

Passing	Percentages by Weight Passing Square Mesh Sieves A.A.S.H.O. T-27			
	Grading "BA"	Grading "BB"	Grading "BC"	Grading "BD"
1 inch sieve	100	100	100	---
3/4 inch sieve	85-100	70-100	---	100
3/8 inch sieve	65-100	50- 80	---	---
No. 4 sieve	55- 85	35- 65	40-75	70-100
No. 10 sieve	40- 70	25- 50	25-60	35- 80
No. 40 sieve	25- 45	15- 30	---	25- 50
No. 200 sieve	10- 25	5- 15	Less than 12	8- 25

The above gradations represent the extreme limits which shall determine the suitability of aggregate for use. The final gradation decided on within the limits designated in the tables shall be uniformly graded from coarse to fine, and shall not vary from the low limits on one screen to the high limits on the adjacent screen, or

vice versa.

The engineer may, when necessary to obtain a desired and uniform mixture, fix the maximum percent of the mineral aggregate passing the No. 4 sieve within the specified limits and the contractor will not be allowed any claim for payment for cost for rejection of fines to conform to such maximum limits.

The fraction passing the No. 200 sieve shall be less than two-thirds of the fraction passing the No. 40 sieve. The fraction passing the No. 40 sieve shall have a liquid limit not greater than 35 and a plasticity index of not less than 4 or more than 9. When produced from gravel, not less than 50 percent by weight of the coarse aggregate particles shall be particles having at least one fractured face and, if necessary to meet this requirement or to eliminate an excess of filler, the gravel shall be screened before crushing.

29.3 CUSHION COURSE

29.3-01 DESCRIPTION. This item shall consist of a single course of crushed gravel material constructed on a prepared base in accordance with these specifications and in conformity with the lines, grades, and thicknesses shown on the plans or designated by the engineer. In general, it will be the gravel course placed between the base course material and the oiled mat.

29.3-02 MATERIAL. The material shall meet all requirements for Type A top course crushed gravel as set forth in Section 29.1-02. The grading shall be as designated on the plans or in the proposal form.

NOTE: Articles 29.01 to 29.08 following apply to the production and placing of base course, Top Course (Type A), Top Course (Type B) and Cushion Course.

29.01 SCREENING AND CRUSHING. It is the intention of these specifications to provide for crushed gravel or crushed rock surfacing, a material containing as large a proportion as possible of crushed material. The entire volume of oversize material in the source, except boulders too large for the crusher, shall be passed through the various crushing or reduction units until such oversize has been reduced to the sizes specified. In no cases shall oversize material smaller than 6 inches in largest dimension be rejected. The crushed material shall be remixed with the screened material so that a uniform product will be obtained.

The screening plant shall consist of a revolving trommel screen, shaker screen or vibratory screen of suitable design to properly classify the required sizes. A storage bin of ample capacity to insure uniform quality and delivery of materials shall be provided. Loading of trucks directly from the conveyor belt from the crusher will not be permitted.

No surfacing material will be accepted which is loaded into trucks in a segregated condition or which does not conform to the required grading.

In case the material deposit contains sand or other material

passing a screen having one-fourth inch square openings, in excess of the specification requirements, or of an unacceptable quality, such excess or undesirable material shall be removed and wasted prior to crushing, or during screening operations if crushing is not required.

When production is from sources made available by the State material wasted in the manufacture of surfacing material shall be disposed of as directed and will remain the property of the State.

29.02 CONSTRUCTION METHODS. Before the placing of any surfacing course is permitted, the subgrade or base shall be brought to a uniform cross section and grade conforming to the plans. Soft or spongy material shall be removed from the subgrade, the holes back-filled with approved granular material and the entire subgrade firmly compacted. Surfacing material shall not be placed upon a wet, uncompacted or unstable base or surface course. Hauling over the subgrade, or over surfacing completed, or in the process of construction, will not be permitted at such times and in such manner as to be detrimental to the subgrade or base. Unless otherwise authorized by the engineer, at least one mile of completely finished base shall be kept in advance of the placing of any surface course.

In addition to the restrictions imposed by State Laws on the speed, size and weight of vehicles, weight of loads and tire equipment (Chapter 171, Laws 1931, as amended by Chapter 147, Laws 1933, Section 1751.1 to 1752.0, Revised Codes of Montana, 1935, as amended by Chapter 184, Session Laws of 1939), the engineer may further restrict the speed of the hauling units and the weight of loads as he may deem necessary to prevent damage to the previously constructed base or surface course or courses.

The mixing, shaping, spreading and maintenance of the surface courses shall be done with a motor grader weighing not less than 14,000 pounds with sufficient tractor power for its efficient operation, or with a blade grader weighing not less than 8,000 pounds pulled by a tractor of sufficient power for efficient operations.

(a) Roller Compaction. Unless otherwise stated in the special provisions, all gravel or rock sub-base, base and surface courses shall be roller compacted. All surface course material shall be placed on the prepared subgrade or base course in horizontal layers of not more than 4 inches loose thickness, each layer being mixed, bladed smooth and thoroughly compacted by rolling before the succeeding layer is placed. The depositing and spreading of the material on the prepared subgrade or base course, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer without segregation of size to such loose depth that when compacted, making due allowances for any filler that is to be blended on the road, the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required the construction procedure described in the next paragraph below shall apply similarly to each

layer.

After the surface course material has been spread, it shall be thoroughly blade mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. A motor grader weighing not less than 14,000 pounds or a blade grader weighing not less than 8,000 pounds, having blades not less than 10 feet long and having sufficient tractor power for their efficient operation, shall be used for the mixing, provided, however, that traveling mixers or traveling plants of a type approved by the engineer may be used in lieu of blade mixing. If additional filler is required it shall be added in conformity with Section 32 of these specifications.

(b) Traffic Compaction. When so indicated on the plans or in the special provisions, the surface course shall be compacted by traffic instead of being rolled as required above. In such case, the depositing and spreading of material on the road shall start at the point nearest the point of loading, and compaction shall be accomplished by directing the hauling and public traffic over the full width of each layer. Blading and/or dragging shall accompany traffic compaction, and the surface shall be kept free of corrugations and waves at all times until the project is completed and accepted. The material shall be sprinkled with water during the blading and/or dragging when and if directed by the engineer. Where the traffic method of compaction is used the material shall be processed and spread as closely behind the dumping units as is practicable, but in no case shall the length of the unprocessed section exceed one-half mile.

29.03 WATERING. Prior to and during the mixing operations, if required, water shall be added to the material as directed by the engineer, or in such amounts that the entire mass during mixing is wetted to such an extent as to prevent segregation of fine and coarse materials. The sprinkler or other water spreading device shall be of such type as to provide a uniform distribution of the water without producing any noticeable washing effect upon the surfacing material and it shall be approved by the engineer prior to use. The amount of water used shall be as directed by the engineer.

29.04 ROLLING. Except where the plans or specifications provide for traffic compaction, material placed shall be compacted to the full width by rolling with a three-wheel power roller weighing at least 8 tons. Rolling shall be done in accordance with Section 22 of these specifications. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding or removing material, as the case may require, until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with a blade or motor grader meeting the requirements given above. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted surface until the final inspection. Along curbs, headers and walls, and at all places not accessible to the roller, the surface course material shall be tamped thoroughly with mechanical

tampers or hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches. The material shall be sprinkled with water during rolling, tamping and blading when and if directed by the engineer.

29.05 SURFACE SMOOTHNESS. The surface of any base course, when finished, shall be such that when tested with a 10-foot straight edge placed on the surface with its centerline parallel to the centerline of the highway, the maximum deviation of the surface from the edge of the straight edge shall no where exceed three-eights of an inch, nor more than 1 inch from a string line stretch between grade stakes at 40' intervals. Should patching of the base course be necessary in order to meet such tolerances, it shall be performed using methods approved by the engineer and using cushion course aggregates. Payment for such cushion course aggregate used for patching shall be at the unit price bid for base course material.

No portion of the completed surface of a cushion course shall be more than one-fourth inch below the edge of a templet 10 feet in length laid parallel to the centerline of the roadway.

29.06 FIELD LABORATORY. Unless otherwise specified in the plans, proposal forms or special provisions, the contractor shall provide and maintain at the site of the work and at a location designated by the engineer, a building to be used by the engineer and as a field laboratory. This building shall be not less than 10 feet in width and 12 feet in length and 8 feet in height, and shall be well constructed and weather proof.

It shall be constructed so that it may be moved from one point to another on the project and shall be fitted with door and windows and equipped with a work bench and chair with a stove and fuel for heating when required. Use of a trailer house, not less than 7 feet wide and 14 feet long, will also be permitted, provided it conforms in other respects with the requirements herein set forth.

Unless otherwise provided in the special provisions, the laboratory after completion of the project shall remain the property of the contractor.

Payment for the laboratory with furnishings, fuel, maintenance and moving on the project as directed, will be considered as covered under the bid prices for surfacing material.

29.07 METHODS OF MEASUREMENT. (a) Gravel or rock surfacing material shall be measured by the cubic yard or by the ton of 2000 pounds as called for in the proposal form. If measured by the cubic yard, the measurement shall be made of the loose material in the vehicle at the point of delivery on the road and in order to aid in the checking of loads, the contractor shall strike or level any load when ordered to do so by the inspector.

If measured by the ton, the material shall be weighed on scales furnished by, and at the expense of, the contractor. The scales shall be satisfactory to the engineer and shall be tested and sealed at the expense of the contractor prior to their use upon the project

and as often thereafter as the engineer may deem necessary to insure their accuracy.

The scales shall be installed under the gravel bin and shall be housed in a suitable manner. They shall be equipped with a telltale or other approved mechanical device which shall indicate when required truck loadings are reached. Trucks shall be loaded only to the nearest one-half ton and each truck shall consistently haul the same tonnage. Trucks shall be so numbered as to clearly indicate the tonnage to be hauled. Varying of loadings in individual trucks shall not be permitted.

(b) Watering, if required, shall be measured by the 1,000 U.S. gallons and the unit bid price shall include the providing and maintaining of the required water plant and units used in the application, unless otherwise stipulated.

(c) Unless otherwise provided in the special provisions, rolling of gravel courses, and of subgrade will be measured as provided in Section 22 of these specifications.

29.08 BASIS OF PAYMENT. The completed and accepted surface courses shall be paid for at the contract unit bid prices for such of the following items as are required to complete the work.

(a) Preparation of Base. Where the contract covers only the placing of surface course or courses, payment for scarifying, blading and shaping and compaction of bases will be considered as included in the other bid items of the contract, unless otherwise noted in the proposal form or special provisions; except that in any case, rolling and watering incidental to preparation of the base shall be paid for separately at the unit bid prices for these items.

(b) Gravel or rock surfacing material shall be paid for by the cubic yard or by the ton as called for on the proposal form, which price and payment shall constitute full compensation for furnishing material and placing same; for mixing, blading and shaping; for cleanup of pits; and for all labor, equipment, tools and incidentals necessary to complete the item.

(c) Water, as required, shall be paid for in units of 1,000 gallons, as provided for in Section 21.04.

(d) Rolling of gravel courses will be paid for in accordance with Section 22 of these specifications. Rolling of subgrade will not be paid for unless the subgrade has been constructed as part of a previous contract.

SECTION 30

STONE CHIPS

30.01 DESCRIPTION. This item shall consist of crushed gravel or stone either (a) placed in stock piles at designated locations for future use, or (b) placed on the roadway in accordance with the quantity shown on the plans or designated by the engineer, and in conformity with the methods hereinafter set forth in Section 39.

30.02 MATERIAL. The material for this work shall be screenings of crushed stone or crushed gravel. It shall consist of clean, tough, durable fragments free from an excess of flat, elongated, soft or disintegrated pieces, clay balls or other objectionable material. Chips as produced shall have a crisp, clean appearance and be free from adherent films of clay or rock dust and shall be washed thoroughly unless otherwise provided in the special provisions. They shall have a per cent of wear not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T 96 (Los Angeles Rattler Test). The abrasion test shall be run using a 5,000 gram sample charge of material between the three-eighth inch and No. 4 sieves and an abrasive charge of 8 balls.

Stone chips shall consist of the product obtained by crushing and screening material that has first been screened in such a manner that not less than 95 percent of the material for crushing, when tested by laboratory methods, is retained on a screen having openings one inch square, unless otherwise specified in the special provisions.

When tested by laboratory screens in conjunction with a water wash, chips shall meet one of the following gradation requirements as specified in the proposal form or special provisions.

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)	
	Grading A	Grading B
1/2 inch	100%	100%
3/8 inch	---	90-100%
No. 4	0-20%	20-60%
No. 10	0-2%	0-8%
No. 100	---	0-2%

30.03 METHODS OF MEASUREMENT. Stone chips shall be measured by the ton of 2,000 pounds unless otherwise specified in the proposal form or special provisions.

All requirements as set forth under Section 29.07, Methods of Measurement, shall be complied with in measuring stone chips.

30.04 BASIS OF PAYMENT. The quantity of stone chips, determined as provided in Section 30.03 above, shall be paid for at the contract unit price bid per ton, delivered to the stock pile or complete in place on the roadway, as may be designated in the proposal form or in the special provisions, which price and payment shall be full compensation for furnishing and placing all materials, labor, equip-

ment, tools and incidentals necessary to complete the item.

Due to the fact that it is not ordinarily feasible to crush out the stone chips as needed, it is impossible to ascertain the exact amount required at the time of crushing and the State will purchase any unused stone chips up to a maximum amount equivalent to the difference between the tonnage set forth in the contract and the tonnage actually used.

For such excess chips the State will pay $1.25 per ton plus $0.10 per ton mile of haul, if the chips are stockpiled more than 2,000 feet from the crusher, provided, however, that if the unit price bid for chips in place is less than $1.25 per ton, the State will recompense the contractor at his bid price.

Purchase of the excess chips by the State will be at the contractor's option. If the contractor does not elect to dispose of the chips at the prices given above, the chips shall remain the contractor's property and the State will disclaim further responsibility in the matter.

SECTION 31

STOCK PILED GRAVEL

31.01 DESCRIPTION. This item shall consist of the placing in stock piles of crushed rock or gravel surfacing material for maintenance or other purposes, at such places as may be directed along and adjacent to the roadway section or at such sites as may be designated in the proposal form or the special provisions.

31.02 MATERIAL. The material shall conform to the specifications for crushed gravel and crushed surfacing material of the same grade as that material used in the construction of the final wearing surface of the roadway or as specified in the proposal form or special provisions.

31.03 CONSTRUCTION METHODS. During the progress of surfacing operations, the contractor shall furnish, deliver and place crushed gravel or crushed rock surfacing material in stock piles at such places along the roadway as the engineer may direct. Unless otherwise specified in the special provisions, the stock piles will be approximately uniform in size and located at regular intervals along the work.

Previous to placing the stock piles, the area which they are to cover shall be cleared of weeds, roots, stumps, rocks, or any other obstructions which might foul the material or hinder subsequent loading operations. The piles shall be shaped and constructed as directed by the engineer.

Where a considerable amount of material is stockpiled at any one location so that it is necessary to construct it more than one truck dump in height, the stock piles shall be constructed by first distributing material over the entire base and building upward in successive layers, not over 3 feet in depth. End-dumping of material over the sides of the pile will not be permitted.

31.04 METHOD OF MEASUREMENT. Stockpiled crushed gravel or rock surfacing material shall be measured by the cubic yard or by the ton of 2,000 pounds as called for in the proposal form. If measured by the cubic yard, the measurement shall be made of the loose material in the vehicle at the point of delivery on the road, and in order to aid in the checking of loads the contractor shall strike or level any load when ordered to do so by the inspector.

If measured by the ton, the material shall be weighed on scales furnished by, and at the expense of, the contractor. The scales shall be satisfactory to the engineer and shall be tested and sealed at the expense of the contractor prior to their use upon the project and as often thereafter as the engineer may deem necessary to insure their accuracy.

31.05 BASIS OF PAYMENT. Stockpiled gravel shall be paid for at the contract price bid per cubic yard or per ton, as called for in the proposal form or the special provisions, which price and payment, except as otherwise expressly provided, shall be full compen-

sation for all materials, labor, equipment, tools and incidentals necessary to complete the item.

SECTION 32

BINDER OR FILLER

32.01 DESCRIPTION. This item shall consist of fine natural soil particles or crusher dust, free from grass, roots, weeds, humus or other undesirable matter, and its binding properties shall be such that when added and blended to crushed gravel or crushed stone surfacing material it will provide the physical structure and properties to the final mixture required by the specifications.

If the material in any base or surface course is, in the opinion of the engineer, deficient in binding quality, or grading characteristics, an approved amount of binder or filler material shall be added; provided, however, that the grading of the final mixture shall not exceed the limits specified for the particular base or surface course.

Binder or filler for base course and top course (Type "A") material shall be of such quality that deficiencies in binding characteristics or grading of the course may be corrected in the most economical and satisfactory manner within the limits of the specifications.

Binder or filler for top course (Type "B") material shall be of such quality that deficiencies in binding characteristics of the course may be corrected without causing the material passing the No. 40 sieve in the resultant mixture to have a Liquid Limit in excess of 35, and so as to result in its having a Plasticity Index of between 4 and 9.

32.02 CONSTRUCTION METHODS. Binder shall be spread uniformly across the roadway over the surfacing material in the amount specified by the engineer. It shall then be thoroughly blended and mixed with the surfacing material by the means specified hereinbefore for mixing or processing surface courses. Where the depth of surfacing is 4 inches or less, the binder shall be processed into the entire depth. Where the depth of surfacing exceeds 4 inches, the binder shall be processed into not less than the upper 4 inches of the surface course.

The source of supply for binder or filler material shall be designated by the engineer and the Commission will furnish this material in its original position without expense to the contractor, except in cases where the material can be obtained within a distance of 1,000 feet from the contractor's crusher and is added at the crushing plant, in which cases the additional binder shall be considered an integral part of the surfacing material and must be supplied by the contractor without additional cost to the Commission.

No binder or filler shall be added, either upon the roadway or through the plant, until tests have been completed and the material approved by the Testing Laboratory.

32.03 METHOD OF MEASUREMENT. Binder or filler which is added after the surfacing material has been placed upon the roadway shall be

measured by the cubic yard loose measurement in the vehicle at the point of delivery upon the road.

Haul on binder or filler shall be measured by the mile yard. The haul distance will be the distance between the center of gravity of the material in its original position and after placing. The distance shall be measured along the shortest practicable route. The number of mile-yards of haul shall be the product of the volume of the material, measured as above provided, in cubic yards, by the haul distance measured in miles.

32.04 BASIS OF PAYMENT. The accepted quantities of this item will be paid for at the contract price per cubic yard bid for "Binder or Filler," which price and payment, except as otherwise expressly provided, shall be full compensation for all materials, labor, equipment, tools and incidentals necessary to complete the item, except haul.

The haul on binder or filler will be paid for at the contract price per mile-yard bid for "Overhaul on Binder," which price and payment shall be full compensation for hauling all material, and for all equipment, tools, labor and incidentals necessary to complete the work.

SECTION 33

LIQUID ASPHALT MATERIALS

33.01 DESCRIPTION. This item shall consist of the furnishing and application of liquid asphalt materials in accordance with these specifications and in conformity with the plans.

33.02 MATERIALS. The bituminous material shall, for each particular kind and grade specified, meet the following requirements:

SPECIFICATIONS FOR SLOW-CURING LIQUID ASPHALTS

Specification Designation	ASTM Test Method	SC-0	SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
General Requirement		The material shall meet the following requirements when tested in accordance with the methods hereinafter enumerated.						
Flash Point (Cleveland Open) °F., not less than	D92	150	150	175	200	225	250	275
Furol Viscosity at 77° F.	D88	75-150						
Furol Viscosity at 122° F.			75-150					
Furol Viscosity at 140° F.				100-200	250-500			
Furol Viscosity at 180° F.						125-250	300-600	
Furol Viscosity at 210° F.								250-500
Water, percent, not more than	D95	0.5	0.5	Material shall be free from water				
Distillation:	D402							
Total Distillate to 680°F.		15-40	10-30	0-25	0-15	0-10	0-5	0-2
Float Test on Residue at 122° F., sec.	D139	15-100	20-100	25-100	50-125	60-150	75-200	150-350
Asphalt Residue of 100 penetration, per cent not less than	D243	40	50	60	70	75	80	90
Ductility of Asphalt Residue at 77°F., not less than	D113	100	100	100	100	100	100	100
Per cent Soluble in CCl_4 not less than	D4 (1)	99.5	99.5	99.5	99.5	99.5	99.5	99.5
Application Temperature °F.		50-125	100-175	150-225	200-300	250-325	275-350	300-400

(1) Use Method No. 1, except that chemically pure carbon tetrachloride shall be substituted for carbon disulphide.

METHOD OF MEASUREMENT. Liquid asphalt shall be measured by the U. S. Gallon at 60° F., or corrected to this basis as prescribed in the Standards of the American Society for Testing Materials, Serial Designation D206-36. RC, MC, and SC grades 2, 3, 4 and 5 and SC-6 shall be governed by the group 0 correction table. RC, MC, and SC grades 0 and 1 shall be governed by the group 1 correction table.

SPECIFICATIONS FOR MEDIUM - CURING LIQUID ASPHALT

Specification Designation	ASTM Test Method	MC-0	MC-1	MC-2	MC-3	MC-4	MC-5
General Requirement		The material shall be free from water and shall meet the following requirements when tested in accordance with the methods hereinafter enumerated.					
Flash Point (Tag. Open) °F., not less than	(1)	100	100				
Flash Point (Cleveland Open) °F., not less than	D92			150	150	150	150
Furol Viscosity at 77°F.	D88	75-150					
Furol Viscosity at 122° F.			75-150				
Furol Viscosity at 140° F.				100-200	250-500		
Furol Viscosity at 180° F.						125-250	300-600
Distillation:	D402						
Distillate (% of total distillate to 680° F.)							
To 437° F.		0- 25	0- 20	0- 10	0- 5	0	0
To 500° F.		40- 70	25- 65	15- 55	5- 40	30-	20-
To 600° F.		75- 93	70- 90	60- 87	55- 85	40-80	20-75
Residue from Distillation to 680° F. Volume % by difference, not less than		50	60	67	73	78	82
Tests on Residue from distillation:							
Penetration 77°F., 100 g., 5 sec.	D5	120-300	120-300	120-300	120-300	120-300	120-300
Ductility 77°F., not less than(2).	D113	100	100	100	100	100	100
Percent soluble in CCl_4, not less than:	D165	99.5	99.5	99.5	99.5	99.5	99.5
Application Temperature °F.		50-125	100-175	150-200	175-225	200-250	225-275

(1) Use method approved by the Bureau of Explosives.

(2) When the penetration of the asphalt is over 200, the ductility shall not be less than 50 at 77° F.

NOTE: The foregoing grades contain approximately the following percentages of solvent: MC-0, 40; MC-1,32; MC-2, 25; MC-3, 20; MC-4, 15; MC-5,10.

SPECIFICATIONS FOR RAPID-CURING LIQUID ASPHALTS

Specification Designation	ASTM Test Method	RC-0	RC-1	RC-2	RC-3	RC-4	RC-5
General Requirement	The material shall be free from water and shall meet the following requirements when tested in accordance with the methods hereinafter enumerated.						
Flash Point (Tag. Open) °F., not less than	(1)			80	80	80	80
Furol Viscosity at 77° F	D88	75-150					
Furol Viscosity at 122° F			75-150				
Furol Viscosity at 140° F				100-200	250-500		
Furol Viscosity at 180° F						125-250	300-600
Distillation:	D402						
Distillate (% of total distillate to 680° F.)							
To 374°F., not less than		15	10				
To 437°F., not less than		55	50	40	25	8	
To 500°F., not less than		75	70	65	55	40	25
To 600°F., not less than		90	88	87	83	80	70
Residue from Distillation to 680°F., Volume % by difference, not less than		50	60	67	73	78	82
Tests on Residue from Distillation:							
Penetration 77°F., 100 g., 5 sec.	D5	80-120	80-120	80-120	80-120	80-120	80-120
Ductility 77°F., not less than	D113	100	100	100	100	100	100
Per cent Soluble in CCl_4, not less than	D165	99.5	99.5	99.5	99.5	99.5	99.5
Application temperature °F		50-125	100-150	125-175	150-200	175-225	200-250

(1) Use method approved by the Bureau of Explosives.

NOTE: The foregoing grades contain approximately the following percentages of solvent: RC-0, 40; RC-1, 32; RC-2, 25; RC-3, 20; RC-4, 15; RC-5, 10.

33.03 METHOD OF MEASUREMENT. (a) The liquid asphalt shall be measured by the U. S. Gallon measured at a temperature of 60 degrees F., or corrected to this basis as prescribed in the standards of the American Society for Testing Materials, Serial Designation D206. The quantity in each car or truck tank shall be determined from the producer's invoice, checked by the engineer in the field.

(b) Application of oil shall be measured by the U. S. Gallon, the measurement being made as herein provided in Paragraph (a).

33.04 BASIS OF PAYMENT. Payment for liquid asphalt shall be made as follows: "Application of Oil" shall be paid for at the contract unit bid price per gallon, which price shall include all demurrage, storage, handling and other charges, all materials (including the road oil), tools, equipment, labor and the performance of all work necessary or incidental to the furnishing, delivering, unloading, heating, hauling and spreading of the oil.

Payment will be made only for the gallonage required and actually used in the work. The State will accept no responsibility for any oil shipped onto the project in excess of requirements because of tank-truck or tank-car capacities or for other reasons.

SECTION 34

ASPHALT CEMENT

34.01 DESCRIPTION. This item shall consist of the furnishing and application of asphalt cement materials in accordance with these specifications and in conformity with the plans.

34.02 MATERIALS. The asphalt cement, for each particular grade specified, shall meet the following requirements:

STANDARD SPECIFICATION FOR ASPHALT CEMENT

(Prepared from Petroleum)

Penetration Grades:+ 30 to 40; 40 to 50; 50 to 60; 60 to 70; 85 to 100; 100 to 120; 120 to 150; 150 to 200.

A. General Requirements

1. The asphalt cement shall be homogeneous, free from water, and shall not foam when heated to a temperature of 175° C.

B. Properties

2. The asphalt cement shall conform to the following requirements:

Penetration at 25° C., 100 g., 5 sec	Note (1)
Total bitumen (soluble in carbon disulphide), not less than ...	99.5%
Proportion of bitumen soluble in carbon tetrachloride, not less than ...	99.0%
Ductility at 25° C., not less than	100 C.M.S.
Flash point, not less than	175° C.
Loss at 163° C., 5 hrs., not more than	1.0%
Penetration of residue at 25° C., 100 g., 5 sec., as compared to penetration before heating, not less than .	75.0%

NOTE 1: Insert penetration limits for grade desired.

C. Sampling and Testing

3. Sampling and testing of asphalt cement shall be in accordance with the following standard methods of American Association of State Highway Officials:

(a)	Sampling	T-40
(b)	Penetration	T-49
(c)	Total bitumen	T-44
(d)	Bitumen soluble in carbon tetrachloride ...	T-45
(e)	Ductility	T-51
(f)	Flash point	T-48
(g)	Loss at 163° C.....	T-47

+The exact penetration grade to be used depends on the type of road, climatic conditions, and kind and nature of traffic. It shall be as specified on the plans or in the special provisions.

34.03 METHOD OF MEASUREMENT. (a) The asphalt cement shall be measured by the U. S. Gallon at a temperature of 60 degrees F., or corrected to this basis as prescribed in the standards of the American Society for Testing Materials, Serial Designation D206. The quantity in each car or truck tank shall be determined from the producer's invoice, checked by the engineer in the field.

(b) Application of asphalt cement shall be measured by the U. S. Gallon, the measurement being made as herein provided in Paragraph (a).

34.04 BASIS OF PAYMENT. Payment for asphalt cement shall be made as follows: Application of asphalt cement shall be paid for at the contract unit bid price per gallon, which price shall include all demurrage, storage, handling and other charges, all materials (including the asphalt cement), tools equipment, labor and the performance of all work necessary or incidental to the furnishing, delivering, unloading, heating, hauling and spreading of the asphalt cement.

SECTION 35

EMULSIFIED ASPHALTS

35.01 DESCRIPTION. This item shall consist of the furnishing and application of emulsified asphalt materials in accordance with these specifications and in conformity with the plans.

35.02 MATERIALS. The type of emulsified asphalt to be used shall be as noted on the plans or in the proposal form or in the special provisions. In general, the type designated for each particular purpose will be as follows:

Type 1 - (Slow setting).

For open-graded coarse aggregate plant mixtures when substantially all of the aggregate is retained on a No. 8 sieve and with practically no material passing a No. 200 sieve.

Type 2 - (Slow setting).

For open-graded coarse aggregate mixed-in-place construction when substantially all of the aggregate is retained on a No. 8 sieve and with practically no material passing a No. 200 sieve.

Type 3 - (Heavy premix - summer grade).

For summer use in bituminous concrete mixtures for repair work.

Type 4 - (Heavy premix - winter grade, non-freezing).

For use in bituminous concrete mixtures for repair work. It shall not separate as a result of freezing. It is slow setting in cold weather.

Type 5 - (Quick setting).

For penetration macadam construction.

Type 6 - (Quick setting).

For the surface treatment of roads.

Emulsified asphalt shall be homogeneous. It shall show no separation of asphalt after thorough mixing, within 30 days after delivery, provided separation has not been caused by freezing.

Prior to the use of any emulsified asphalt, a sample may be tested by the Commission, and if it fails to comply with the specification requirements, the material shall be rejected. The sample shall be taken under the supervision of the Commission, from factory storage containing not less than 20,000 gallons of the emulsified asphalt; and shall be kept in a clean, airtight, sealed

glass or black-iron container at a temperature of not less than 40° F. until tested.

At least one sample of not less than one gallon shall be taken from each lot or shipment of the emulsified asphalt after arrival at its destination. The samples shall be stored in clean, airtight glass or black-iron containers at a temperature of not less than 40° F. until tested.

Testing of emulsified asphalt shall be done in accordance with A.A.S.H.O. Method T 59 (A.S.T.M. D 244).

The emulsified asphalt shall, for each particular kind and grade specified, meet the following requirements:

SPECIFICATIONS FOR EMULSIFIED ASPHALTS

		Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Viscosity, Saybolt Furol (77°F.)	Not less than and	100 sec.	20 sec.			30 sec.	100 sec.
	Not more than		100 sec.			65 sec.	600 sec.
Residue by distillation, not less than		60%	55%	65%	65%	55%	55%
Settlement, 5 days, not more than		5	5			3	3
Demulsibility (Note), 35 ml. of 0.02 N $CaCl_2$,	Not more than					(2)	65% (1)
Demulsibility (Note) 50 ml. of 0.1N $CaCl_2$	Not more than	45%	45%				
Sieve test, not more than		0.10%	0.10%	0.10%	0.10%	0.10%	0.10%
Miscibility with water - no appreciable coagulation in		2 hrs.	2 hrs.	2 hrs.			

Note: The demulsibility test shall be made within 30 days from date of shipment.
(1) Or less than 30%. (2) Not less than 60%

TESTS ON RESIDUE FROM DISTILLATION

Penetration at 77° F.	100-200	100-200	100-200	125-225	150-200	200-300
Solubility in Carbon Disulphide, not less than	95%	95%	95%	95%	95%	95%
Ash, not more than	2%	2%	2%	2%	2%	2%
Ductility, not less than	40 cm	40 cm	40 cm	40 cm	40 cm	40 cm
Specific Gravity at 77°/77° F, not less than	1.00	1.00	1.00	1.00	1.00	1.00

Coating test: Types 1, 2, 3, 4 shall not show appreciable separation when mixed with washed, dry, clean stone for 3 minutes and shall coat the stone thoroughly.

Type 4 shall remain homogeneous after 3 cycles of the freezing test.

35.03 METHOD OF MEASUREMENT. (a) The emulsified asphalt shall be measured by the U. S. Gallon at a temperature of 60 degrees F., or corrected to this basis as prescribed in the standards of the American Society for Testing Materials, Serial Designation D206. The quantity in each car or truck tank shall be determined from the producer's invoice, checked by the engineer in the field.

(b) Application of emulsified asphalt shall be measured by the U. S. Gallon, the measurement being made as herein provided in Paragraph (a).

35.04 BASIS OF PAYMENT. Payment for emulsified asphalt shall be made as follows: Application of emulsified asphalt shall be paid for at the contract unit bid price per gallon, which price shall include all demurrage, storage, handling and other charges, all materials (including the emulsified asphalt), tools, equipment, labor, and the performance of all work necessary or incidental to the furnishing, delivering, unloading, heating, hauling and spreading of the emulsified asphalt.

SECTION 36

BITUMINOUS SURFACE TREATMENT

Type A

36.01 DESCRIPTION. This item shall consist of a bituminous surface treatment composed of a prime coat, a mat substantially the thickness of the largest aggregate specified and a seal coat. It shall be constructed on a properly prepared base course which may consist of either a naturally stable earth base course, artificially stabilized base course, a macadam base course, a bituminous treated base course or other base or cushion course as required. It shall be constructed in accordance with the lines, grades and typical cross-section as shown on the plans.

Where the earth or macadam base course, on which the bituminous surface treatment is to be placed, has been constructed under a previous contract it shall be brought to line and grade and compacted as specified in Section 25. If the surface treatment is to be placed on a previously bituminized surface, the existing road surface shall be brought to uniform contour by patching all depressions and defective areas and by eliminating in an approved manner all bumps and similar irregularities.

36.02 SEQUENCE OF OPERATIONS.

1. The base course shall be thoroughly cleaned and then primed with the bituminous material specified.

2. After the prime coat has dried and "set" the mat shall be constructed using one application of bituminous material covered with a uniform application of aggregate.

3. After the aggregate has become thoroughly embedded and keyed into the bituminous material the seal coat shall be applied.

36.03 MATERIALS. The bituminous materials used shall be of the kind and grade specified in the proposal form or special provisions and shall conform to the requirements set forth in Sections 33, 34, or 35.

The aggregates shall be either crushed stone, crushed gravel or screened gravel as specified in the proposal form or the special provisions. Aggregates shall consist of clean, tough, durable particles, free from soft, thin, elongated or laminated pieces, disintegrated particles, vegetable or other deleterious substances. The Los Angeles abrasion loss shall not exceed 40 per cent.

The grading of the aggregate for the mat course shall conform to the requirements shown below for "Coarse Aggregate" and the grading of the aggregate used in the seal coat shall conform with the requirements shown below for "Fine Aggregate."

Sieve Designation	Coarse Aggregate Minimum	Coarse Aggregate Maximum	Fine Aggregate Minimum	Fine Aggregate Maximum
Passing 1-1/2" (Square Openings)	100			
Passing 1 " (Square Openings)	90	100		
Passing 3/4" (Square Openings)	30	60		
Passing 1/2" (Square Openings)	0	10	100	
Passing 3/8" (Square Openings)			90	100
Passing No. 4	0	2	20	60
Passing No. 10			0	8
Passing No. 100			0	2

36.04 QUANTITIES. (a) Prime Coat. The bituminous material for the prime coat shall be applied at the rate shown on the plans or as designated by the engineer. A tolerance of 0.03 gallon from the specified amount will be allowed.

(b) Mat Course. The bituminous material for the mat course shall be applied at the rate shown on the plans or as designated by the engineer. A tolerance of 0.03 gallon from the specified amount will be allowed.

The coarse aggregate for the mat course shall be applied at the rate of 45 to 50 pounds per square yard. The amount shall be adjusted by the engineer so that the quantity applied shall be just sufficient to result in a uniform cover without excess material.

(c) Seal Coat. The bituminous material for the seal coat shall be applied at the rate of 0.30 to 0.35 gallon per square yard, the exact quantity to be indicated by the engineer, and shall be applied in one application.

The fine aggregate for the seal coat shall be applied at the rate of 22 to 24 pounds per square yard.

36.05 EQUIPMENT. Spreading of the bituminous material shall be accomplished by means of a pressure distributor meeting the requirements of Section 38 of these specifications.

The roller shall have a pressure per inch width of tread of not less than 125 pounds and not more than 250 pounds. The maximum total weight of the roller shall not exceed 10 tons. In lieu of this roller, a roller with pneumatic tires meeting the approval of the engineer may be used.

36.06 CONSTRUCTION METHODS. (a) Application of Bituminous Materials - General. No bituminous surfacing work will be performed between September 15th and May 15th except with the written consent of the engineer. The bituminous material shall be applied at the temperature specified and shall be applied only when the road surface is dry. No oil shall be applied when either the atmospheric temperature in the shade or the road surface temperature is below 65 degrees F. or when weather conditions are otherwise unfavorable.

Bituminous materials shall be applied in one application for

the full width to be treated, or for such lesser widths as directed by the engineer. Care shall be exercised to secure a neat and exact junction between adjacent applications. The distributor shall be so adjusted and operated as to distribute the material uniformly over the required width. Excessive deposits of bituminous materials shall be removed immediately by the contractor.

To secure a uniform distribution of bituminous material at the junction of two applications, the distribution shall be promptly stopped when the flow begins to thin just before the tank is empty. The distributor shall be equipped with a trough under the sprayers so arranged as to be swung out of the way after the sprayers are operating in a uniform manner at the desired pressure, or in lieu of this trough, building paper shall be spread over the treated surface for sufficient length back so that the sprayers are operating properly when the uncovered section is reached. The building paper shall then be gathered and burned.

(b) Prime Coat. The surface of the base course to be treated shall be reasonably dry and shall be free of dust and loose material at the time the prime coat is applied. In cleaning the base the contractor shall use mechanical blowers or rotary sweepers, hand brooms, mechanical brooms or other equipment acceptable to the engineer.

Traffic shall not be permitted on the prime coat until the bituminous material has penetrated the base and dried and will not pick up under traffic. The prime coat shall be allowed to cure for a period of not less than 24 hours. The contractor shall maintain the primed surface and shall clean any area that has become fouled by traffic, or otherwise, before the next course has been placed.

(c) Mat Course. As soon as the bituminous material for the mat course has been applied, it shall be uniformly covered with sufficient coarse aggregate to secure a complete cover. The aggregate shall be applied by means of a mechanical spreader designed to give (1) a uniform cover of material for the full width to which it is applied and (2) rate of cover independent of the speed at which the spreader is operated. These spreaders shall be supplemented by hand spreading, when necessary, in order to secure a uniform cover. Spreading of the aggregate shall be maintained as close to the applications of the bituminous material as is practicable and each distributor load of bituminous material shall be covered with aggregate before additional bituminous material is applied, but, in any event the work shall be so conducted that all bituminous material is covered within 20 minutes after the time it is applied to the roadway. Where the bituminous material is not applied to the full width of the roadway in one application, adjacent applications shall be placed within a sufficiently short time to prevent the first application setting sufficiently to preclude adherence of chips adjacent to the joint between the two applications.

Surplus aggregate that, in the judgment of the engineer, is injurious to the finished road shall be removed.

(d) Rolling. The coarse aggregate shall be rolled for its entire width as soon as practicable after it has been applied. The rolling of the coarse aggregate shall be repeated as often as is necessary to insure that the coarse aggregate is thoroughly keyed into the bituminous material. Rolling, however, shall be discontinued before appreciable crushing of the aggregate develops. Rolling shall begin at the edges and progress in a longitudinal direction toward the center of the area being treated, uniformly lapping each preceding track by at least one-half the width of the roller and covering thoroughly the entire surface. Traffic may use the road as soon as the coarse aggregate has been spread and in this case it will be distributed uniformly over the entire road surface by suitable traffic divides.

(e) Seal Coat. The seal coat shall be constructed as follows: After the coarse aggregate has been uniformly distributed and rolled, hot bituminous material shall be applied over the coarse aggregate at the rate specified and shall be covered immediately with the specified quantity of fine aggregate spread uniformly over the portion of the surface being sealed. Immediately after the fine aggregate is spread, the surface shall be broomed lightly with approved push or drag brooms to insure an even distribution of the aggregate and then rolled until a smooth compacted surface course is obtained. Brooming and rolling shall be repeated as may be necessary to secure a compacted surface course.

36.07 PROTECTION OF ROADWAY STRUCTURES AND TRAFFIC. All bridges, sign posts, guard fence and any other roadside structures shall be adequately protected from being discolored by splashing oil. Compensation for furnishing, erecting and removing such protection shall be included in the unit price bid for the application of the oil. Should any splashing result, the contractor will be required to clean the surfaces and restore them to their previous condition without additional compensation.

When the roadway is under traffic, the bituminous material shall not be applied to more than one-half the width of the roadway at a time and if directed by the engineer, it shall be placed on only one-third of the width of the roadway at a time. In either case, the remaining section of the roadway shall be kept clear and open for traffic.

In addition to the safety measures provided for under Sections 7.07 and 7.08, the contractor will be required to maintain two watchmen, one at each end of the work, and a pilot car and operator to lead and direct traffic through the work, at all times that work is in progress and for a period of 4 hours after the completion of any section. The object of this latter provision is to reduce the amount of whip-off due to fast traffic prior to the time the bituminous material has had an opportunity to set up and bond firmly to the cover material.

36.08 METHOD OF MEASUREMENT. (a) Bituminous material shall be measured as provided under Sections 33.03, 34.03 or 35.03 of these specifications.

(b) Fine and coarse aggregate shall be measured as provided under Section 29.06 of these specifications.

(c) Rolling will be measured as provided for under Section 22.04 of these specifications.

36.09 BASIS OF PAYMENT. (a) Bituminous material and the application thereof shall be paid for as provided under Sections 33.04, 34.04 or 35.03 of these specifications.

(b) Fine and coarse aggregate shall be paid for as provided under Section 29.07 of these specifications.

(c) Rolling will be paid for as provided in Section 22.05 of these specifications.

SECTION 37

BITUMINOUS SURFACE TREATMENT

Type B

37.01 DESCRIPTION. This item shall consist of a bituminous surface treatment composed of a prime coat and a seal coat. It shall be constructed on a properly prepared base course which may consist of either a naturally stable earth base course, artificially stabilized base course, a macadam base course, a bituminous treated base course or other base or cushion course as required. It shall be constructed in accordance with the lines, grades and typical cross-sections as shown on the plans.

When the earth or macadam base course, on which the bituminous surface treatment is to be placed, has been constructed under a previous contract, it shall be brought to line and grade and compacted as specified in Section 25. If the surface treatment is to be placed on a previously bituminized surface, the existing road surface shall be brought to uniform contour by patching all depressions and defective areas and by eliminating in an approved manner all bumps and similar irregularities.

37.02 SEQUENCE OF OPERATIONS.

1. The base course shall be thoroughly cleaned and then primed with the bituminous material specified.

2. After the primed coat has dried and "set" the seal shall be applied, using one application of bituminous material covered with a uniform application of aggregate.

37.03 MATERIALS. The bituminous materials shall be of the kind and grade specified in the proposal form or in the special provisions and shall conform to the requirements set forth in Sections 33, 34 and 35.

The cover aggregate shall conform to either the requirements for "Stone Chips", Section 30, or for "Rock or Gravel Surface Courses, Top Course (Type A)", Section 29, as specified in the proposal form or special provisions.

37.04 QUANTITIES. (a) Prime Coat. The bituminous material for the prime coat shall be applied to the road surface at the rate of 0.2 to 0.5 gallon per square yard, the exact quantity to be determined by the engineer, and shall be applied in one application.

(b) Seal Coat. The bituminous material for the seal coat shall be applied at the rate of 0.30 to 0.35 gallon per square yard, the exact quantity to be determined by the engineer. The cover aggregate shall be applied at the rate of 20 to 25 pounds per square yard of surface, or as designated by the engineer

37.05 EQUIPMENT. Spreading of the bituminous material shall be accomplished by means of a pressure distributor meeting the require-

ments of Section 38 of these specifications.

The roller shall have a pressure per inch width of tread of not less than 125 pounds and not more than 250 pounds. The maximum total weight of the roller shall not exceed 10 tons. In lieu of this roller, a roller with pneumatic tires meeting the approval of the engineer may be used.

Spreading of cover material shall be done only with mechanical spreaders designed to give a uniform cover of material for the full width to which it is applied. Spreaders shall be so designed that the rate of cover is independent of the speed at which the unit is operated.

37.06 CONSTRUCTION METHODS. (a) Application of Bituminous Materials - General. No bituminous surfacing work will be performed between September 15th and May 15th except with the written consent of the engineer. No oil shall be applied when either the atmospheric or road surface temperature is below 65 degrees F. or when weather conditions are otherwise unfavorable. Application of bituminous material when the road surface is wet or damp will not be permitted.

Bituminous materials shall be applied in one application for the full width to be treated, or for such lesser widths as directed by the engineer. Care shall be exercised to secure a neat and exact junction between adjacent applications. The distributor shall be so adjusted and operated as to distribute the material uniformly over the required width. Excessive deposits of bituminous materials shall be removed immediately by the contractor.

To secure a uniform distribution of bituminous material at the junction of two applications, the distribution shall be promptly stopped when the flow begins to thin just before the tank is empty. The distributor shall be equipped with a trough under the sprayers so arranged as to be swung out of the way after the sprayers are operating in a uniform manner at the desired pressure, or in lieu of this trough, building paper shall be spread over the treated surface for a sufficient length back so that the sprayers are operating properly when the uncovered section is reached. The building paper shall then be gathered and burned.

(b) Prime Coat. The surface of the base course to be treated shall be reasonably dry and shall be free of dust and loose material at the time the prime coat is applied. In cleaning the base the contractor shall use mechanical blowers or rotary sweepers, hand brooms, mechanical brooms, or other equipment acceptable to the engineer. Immediately following the sweeping of the roadway the prime coat shall be applied to the road surface at the rate specified.

Traffic shall not be permitted on the prime coat until the bituminous material has penetrated the base and dried and will not pick up under traffic. The contractor shall maintain the primed surface and shall clean any area that has become fouled by traffic, or otherwise, before the next course has been placed.

(c) Seal Coat. After a period of not less than 3 days nor more than 5 days following the application of the prime coat, the road shall again be cleaned by sweeping with a power broom. Any holes that have developed in the surface shall be cleaned of all loose material and a small amount of the grade of bituminous material specified for the seal coat shall be placed in the bottom and the holes then filled with stone chips. The patch shall then be tamped until the bituminous material flushes through. Deep holes shall be filled with two layers similarly constructed. The cost of such patching will not be paid for directly but shall be considered as incidental to the completion of the bid items of the contract.

Cover material shall be spread in accordance with the provisions of Section 39. Immediately after the cover material is spread, the surface shall be broomed lightly with approved push or drag brooms to insure an even distribution of the cover material and shall be rolled until a smooth uniform surface is obtained.

(d) Rolling. Rolling shall be done in accordance with Section 22 of these specifications.

37.07 PROTECTION OF ROADWAY AND TRAFFIC. Protection of roadway structures and traffic shall be done in accordance with Article 36.07 of these specifications.

37.08 METHOD OF MEASUREMENT. (a) Bituminous material shall be measured as provided under Sections 33.03, 34.03, or 35.03 of these specifications.

(b) Stone chips shall be measured as provided under Section 30.03 of these specifications.

(c) Rolling will be measured as provided for in Section 22.04 of these specifications.

37.09 BASIS OF PAYMENT. (a) Bituminous material and application thereof shall be paid for as provided under Section 33.04, 34.04, or 35.04 of these specifications.

(b) Stone chips cover material and/or application thereof shall be paid for as provided under Section 30.04 of these specifications.

(c) Rolling will be paid for as provided in Section 22.05 of these specifications.

SECTION 38

ROAD MIX BITUMINOUS SURFACE COURSE

38.01 DESCRIPTION. This item shall consist of a wearing course composed of a mixture of crushed rock or crushed gravel and bituminous material prepared on the roadbed by mechanically mixing the bituminous material and the aggregate, and spreading and compacting the mixture to the width, thickness and typical cross-section shown on the plans.

Mineral aggregate for the bituminous treatment shall be obtained either from all new material, from a blend of new material and aggregate present in the existing road surface or entirely from aggregate present in the existing surface as may be required by the plans and specifications.

38.02 MATERIALS. (a) The crushed rock or crushed gravel aggregate shall conform to the requirements of Section 29 and to the grading specified.

(b) The bituminous material shall, for each particular kind and grade specified, meet the requirements of Sections 33, 34, or 35.

38.03 ORGANIZATION AND EQUIPMENT. Each contractor's crew or outfit shall be under the continuous supervision of a competent superintendent, thoroughly experienced in the class of work involved, and all equipment shall be manned by experienced operators. All wheeled equipment, except scarifiers and rollers, shall be equipped with rubber-tired wheels and all equipment shall be kept in good condition and repair at all times.

On projects 5 miles or more in length, the organization and equipment shall be such as to provide for the completion of at least 1/2 mile of continuous road mix surface per day. On projects of less than 5 miles in length, organization and equipment must be such as to permit completion of the mat-laying operation in 10 working days or less. The rates of progress on the various operations shall be such that a minimum length of road shall be under construction at one time.

Regardless of the length of project, or the type of mixing equipment used, the contractor will be required to maintain on the project a pressure distributor of at least 1,000-gallon capacity meeting the following requirements: The tank shall be insulated and equipped with internal steam coils or equivalent heating facilities. The distributor shall be equipped with a spray bar of the full circulating type at least 9 feet in length. The header box shall be adjustable to permit varying height above the surface being treated. The nozzles attached to the bar shall be either of the conical or flat-slotted type. The valves which control the flow from nozzles shall be of positive acting design so as to provide a uniform unbroken spread of bituminous material on the surface. The distributor shall be equipped with devices and charts to provide for accurate, rapid determination and control of the amount of

bituminous material being applied per square yard of surface and with a tachometer of the fifth-wheel type reading speeds in feet per minute. The pressure pump shall be powered independently from the propelling motor of the vehicle. The distributor shall be equipped with a pressure pump, pressure gauge, thermometer well, thermometer and an accurately calibrated fluid content gauge. The distributor shall be equipped with pneumatic tires of sufficient number to meet the legal road requirements of the State and shall be adequately powered to perform the necessary work without assistance from other units.

The contractor shall also maintain on the project one self-propelled roller, preferably of the tandem type, weighing from 8 to 10 tons. Rollers weighing over 10 tons or pneumatic-tired rollers may be used only by written permission of the engineer. Pneumatic-tired rollers may be used only for the preliminary compaction and the final rolling shall be done with a steel-tired roller. Rollers shall be equipped with the necessary facilities to prevent adhesion of bituminous-treated material to the wheels.

Sufficient mixing units shall be maintained on the project to insure compliance with the required rate of progress. Blade mixing units may be either adequately powered, rubber-tired motor graders with moldboards not less than 10 feet long, or rubber-tired graders with wheelbase not less than 16 feet in length and moldboards not less than 10 feet long powered by crawler-type tractors of not less than 35 horsepower, equipped with street plates. Units used for scarifying shall have a scarifier attachment so constructed as to provide positive adjustment of scarifier depth.

Track type tractors shall be equipped with flat, smooth treads. Tractors of the track-laying type shall not turn on the completed bituminous surface at any time.

In the event road-mix machines are used, the contractor will be required to maintain and keep in use on the project not less than two motor graders, meeting the requirements as hereinbefore specified for mixing units, which shall be used for windrowing and equalizing the stack, to complete the mixing or aerating of the material, to produce uniform distribution of oil and aggregate and to lay the mixed material.

Where mixing machines are used, the device for picking up the windrow shall take up all the loose material and leave the base clean. The contractor shall clean up and salvage all material falling outside the pick-up device. All traveling road-mix machines permitted for use shall be equipped with tracks, wheels or treads of satisfactory bearing, width and type, so that no damage will result to the base course.

Proportioning of the liquid asphaltic material to the aggregate in the traveling plant shall be by weight or a satisfactory volumed equivalent. A positive adjustable measuring device insuring accurate control of the quantity of liquid asphaltic material shall be provided on the traveling plant and shall be set by order of the

engineer and not varied except by his permission.

38.04 CONSTRUCTION METHODS. The point or points where the contractor shall start work shall be outlined by the engineer. No work will be prosecuted except in daylight hours without written permission of the engineer.

No work shall be started prior to May 1st nor shall it be continued later than September 15th, except on written permission of the engineer.

The contractor shall not open up more than 3 miles at one operation and at no time shall there be more than 4 miles under process of actual oiling construction.

Where material for the oil mat is to be obtained in whole or in part from the existing roadway, the surface shall be scarified, parallel with the finished grade and cross-section, to a depth which will produce the quantity of loose material required for the compacted thickness of the bituminous surfacing shown on the plans or to the extent permittted by the depth of suitable aggregate in the roadway. Extreme care shall be exercised to avoid loosening the floor or scarifying below the depth necessary to produce the required amount of material. After scarifying, all clods shall be broken and the loose material shall be bladed into a windrow. The base shall then be bladed into a windrow. The base shall then be bladed and compacted by watering and rolling, if required. The crown on the floor, produced by scarifying, shall conform to the crown for the finished section shown on the plans.

When new aggregate is to be used for the bituminous mat, the material shall be placed in a uniform windrow on one side of the roadway, except when the bituminous treatment is not to follow for a considerable period, in which case the material shall be uniformly spread over the roadway surface.

After the material, either new material or material from the existing roadway, is windrowed at one side of the roadway, the windrow shall be equalized in size throughout its entire length by means of graders or mechanical equalizing devices. If necessary in order to secure uniformity of the windrow, material shall be hauled from sections where there is an excess of material to those where a deficiency exists.

The bituminous material shall be applied, at the temperature specified, by spreading from the windrow a layer of aggregate which shall not extend more than 14 feet out from the windrow into the roadway, and applying thereon the first application of bituminous material specified. The operation shall continue by blading successive layers of aggregate from the windrow, upon each of which additional bituminous material is spread. Not less than three layers of aggregate and applications of bituminous material shall be made.

The amount of bituminous material to be applied shall be determined by the engineer according to the grading of the surfacing material to be mixed, and the amount of asphalt required shall be

estimated by the engineer from day to day.

After the last application of bituminous material and partial mixing, the entire mass of surfacing material shall be moved by heavy blade graders into a windrow. The windrow shall then be moved from side to side of the roadway with a revolving motion until all particles of aggregate are coated with bitumen and the whole mass has a uniform color and bituminous content.

At least eight moves of the material across the roadway as above described will be required, under the most favorable conditions of air temperature, material, grading, efficiency of equipment and skillful workmanship. A move shall be understood to consist of the movement of the entire mass from one edge of the proposed oil section to the other. Under conditions less favorable for effective mixing, as many more moves will be required as is necessary to produce the desired uniformity of mixture.

The moving or mixing shall be carried on in such a manner that there will be neither segregation of material nor loss of mineral filler from the mixture.

No portion of the mixed material shall be spread or allowed to remain on the roadway until the entire mass of material is thoroughly mixed, when it shall be spread and placed in one operation, unless in the judgment of the engineer, it may be expedient to permit the dropping of a small portion of the mixture to serve as a mixing floor. In no case shall any material be dropped for a mixing floor unless directed by the engineer.

In lieu of mixing the material as above specified, any equipment other than that required above may, with the approval of the engineer, be employed which will comply with these specifications and which will produce a completed mixture equal to that which would be produced by the means above specified. The Commission reserves the right to order the use of any equipment discontinued which in the opinion of the engineer may damage to some extent a section or portion of the roadway or which may fail to produce a satisfactory mixture.

After the mixing operation is completed, the windrow shall be examined to determine whether or not the proper proportion of bituminous material has been used. If the proportion of bituminous material is excessive, additional uncoated material shall be hauled on the moist section at the option of the engineer and shall be thoroughly mixed with the original mass by blading. If more bituminous material is required a portion of the mixed material shall be spread upon one side of the roadway, the required additional bituminous material distributed thereon, and the mixing resumed until uniformity is secured.

After a satisfactory mixture has been secured, the surfacing material shall be spread to a uniform thickness by a pneumatic-tired motor grader having a wheel base of not less than 16 feet and weighing not less than 14,000 pounds.

Immediately following the spreading and smoothing of the mixture to the satisfaction of the engineer, it shall be initially compacted with a roller or rollers of the type required herein. This initial compaction shall consist of at least one and not more than two complete passages of the roller across the surface section. After this work has been performed the surface shall be permitted to cure for not less than 6 hours nor more than 24, when additional rolling shall be performed as is directed by the engineer. The finished surface shall be smooth and free from all marks of the roller. Areas not accessible to power rollers shall be compacted by hand tamping.

The moisture content of the aggregate to be treated shall not exceed 1.5 per cent. If more than this amount of moisture is present, the aggregate must be dried before applying the bituminous material. If rain commences to fall during the application of the bituminous material or the mixing operation, the material shall be windrowed promptly. The treated material and the base shall be allowed to dry before the resumption of any work, except such additional mixing or moving as will facilitate evaporation. In no case shall the treated material be placed while damp or wet. The engineer shall be sole judge as to when the roadbed has dried sufficiently for work to be resumed. However, in no case shall the moisture content in the upper 6 inches of the base be more than 3-1/2 per cent when the mixed material is spread.

The engineer shall have the right to control the application of bituminous material during the periods when weather conditions are such as to result in loss of, or damage to, the bituminous material.

Any oversize aggregate which may enter the mix, regardless of its origination, shall be forked from the roadway during the progress of the mixing at the contractor's expense. Oversize shall be considered as any foreign material or any rock which will not pass a 1-1/2 inch square opening.

Any defects, such as ravelling, low centers, lack of uniformity or other imperfections caused by faulty workmanship shall be corrected to the satisfaction of the engineer and new work shall not be opened up until such defects have been remedied.

All bridges, sign posts, guard fence and any other roadside structures shall be adequately protected from being discolored by splashing oil. Compensation for furnishing, erecting and removing such protection shall be included in the unit price bid for the application of the oil.

No oil shall be spread as a tack coat or seal coat except under the direction of the engineer.

Any costs necessitated through the required addition of bituminous material or untreated surfacing material to correct the uniformity of the mix, or any additional material or work required due to the entrance of moisture or for any other reason prior to the completion of the final rolling of the surface, shall be considered

incidental to the unit price of bid items and no additional compensation for such additional work will be allowed.

However, after the bituminous material has been mixed with the aggregate and has been spread and finally compacted in compliance with these specifications and any special provisions attached to the proposal form and to the satisfaction of the engineer, then any additional materials and work where tearup and reprocessing are required shall be paid for on a force account basis. This provision shall not cover failures which result from the effects of rain during the spreading or rolling operation or failures which may be patched or repaired by hand methods, but shall apply to those sections of the surface which necessitate tearing up with motorized equipment, adding additional bituminous material or mineral aggregate, remixing, relaying and compacting.

The finished surface shall be smooth and true to grade and cross-section and free from ruts, bumps or other irregularities. When tested with a 10-foot straight edge laid on the finished surface parallel to the centerline, the surface shall vary in no place more than 1/4 inch from the lower edge of the straightedge. Any variations shall be corrected by scarifying and relaying at the contractor's expense.

38.05 CONSTRUCTION OF SHOULDERS. After the oil mat has been laid the roadway shoulders shall be built up to the grade and cross-section shown on the plans. Material for the shoulders may be cut from the stack prior to the application of the bituminous material and windrowed on each shoulder or it may be placed on the shoulder after completion of the oil mat, using a spreader box or other approved means to secure a uniform distribution of material. The shoulder surface shall form a smooth uniform continuation of the surface of the oil mat with no depressions or unfilled areas at the junction of the oil mat and the gravel shoulder. Any untreated material that may have been spilled onto the mat shall be removed.

The surfacing material required to construct the shoulders shall be paid for at the price bid for "Top Course Surfacing Material", which price shall be full compensation for producing, placing and compacting the shoulder material.

38.06 PROTECTION OF ROADWAY STRUCTURES AND TRAFFIC. The contractor shall recondition at his expense, any damage done to the highway or structures due to the operation of his equipment or caused by traffic being forced away from the usual lines of travel.

In addition to safety measures provided for in Section 7.07 and 7.08 the contractor will be required to maintain two watchmen, one at each end of the work at all times it is in progress, in order to warn and direct traffic. Work will be considered in progress at all times contractor's equipment is on the roadway, regardless as to whether it is in motion or not, or when material has not been stacked in a safe manner, satisfactory to the engineer. All material shall be left in a uniform stack, placed where the engineer may direct, at night or at other times when work is not in progress, in order to leave the roadway in the best possible condition for

the safe use of the public.

Unless otherwise noted in the special provisions, the contractor will be required to furnish a pilot car to lead and direct traffic through the work at all times when equipment is on the roadway or in operation thereon.

At night the treated or untreated gravel stack shall be lighted with lanterns or suitable flares which shall be spaced at such intervals as to clearly indicate the position of the windrow and at such other intervals as may be indicated by the engineer. If rain occurs and the treated or untreated material is windrowed on the roadway, the contractor shall not allow puddles of water to remain on the roadway, but shall promptly drain them to the ditches.

38.07 METHODS OF MEASUREMENT. (a) The surfacing material required to supplement the aggregate obtained from the existing surface or to construct the shoulders shall be measured by the cubic yard or by the ton of 2,000 pounds as called for in the proposal form, and as more particularly provided under Section 29.07 of these specifications.

(b) The asphaltic road oil shall be measured by the U. S. gallon measured at a temperature of 60 degrees F., or corrected to this basis as prescribed in the standards of the American Society for Testing Materials, Serial Designation D 206. The quantity in each car or truck tank shall be determined from the producer's invoice, checked by the engineer in the field.

(c) Application of oil shall be measured by the U. S. gallon, the measurement being made as herein provided in Paragraph (b).

(d) Processing for all oil treated surfacing material complete in place and accepted by the engineer, shall be measured by the mile, measured along the centerline of the roadway, or by the square yard, as called for in the proposal.

(e) Rolling shall be measured as provided in Section 22 of these specifications.

38.08 BASIS OF PAYMENT. Payment for bituminous surface construction shall be made as follows:

(a) The surfacing material required in addition to the aggregate obtained from the existing road surface to construct the bituminous surface course or the shoulders shall be paid for by the cubic yard or by the ton as called for in the proposal form.

(b) Application of oil shall be paid for at the contract unit bid price per gallon, which price shall include all demurrage, storage, handling and other charges, all materials (including the road oil), tools, equipment, and labor, and the performance of all work necessary or incidental to the furnishing, delivering, unloading, heating, hauling and spreading of the oil.

(c) Processing shall be paid for at the contract unit price bid per mile or per square yard, as the case may be, which price and payment shall constitute full compensation for preparing subgrade or base, for furnishing, handling, mixing, manipulating and placing all materials required under these specifications for which payment is not otherwise provided, for all shaping, compacting and rolling, for reconditioning any part of the highways or structures damaged by traffic or the contractor, and for all labor, equipment, tools and incidentals necessary to complete the item.

(d) Rolling shall be paid for as provided in Section 22 of these specifications.

SECTION 39

PLANT-MIX SURFACE COURSE

(Dense Graded)

39.01 DESCRIPTION. This item shall consist of a wearing course composed of aggregate and bituminous material mixed in a central plant, constructed on the prepared base in accordance with these specifications and in conformity with the lines, grades and typical cross-section on the plans.

When called for on the plans the item shall be constructed in two courses, a binder or leveling course and a wearing course, each of full width and of the weight per square yard required by the plans. The leveling or binder course shall be rolled and finished before the placement of the wearing course in the manner hereinafter specified for the latter.

39.02 MATERIALS. (a) Mineral Aggregate. The bid schedule indicates the particular grading given in this section to which the aggregate must conform. Aggregates shall also conform in all other respects with the requirements set forth in Section 29, with the further limitation that the grading of aggregate produced during any one 8-hour "run" shall be held to such uniformity that percentages of material passing the Nos. 4, 10 and 200 sieves for any one sample shall not vary from the average of all samples for the "run" by more than the following tolerances:

Material Passing	Percent
No. 4 sieve	± 5
No. 10 sieve	± 5
No. 200	± 2

Aggregate for all gradings, except E-1, E-2 and E-3 shall consist of coarse aggregate of crushed gravel or crushed stone, in either case composed of hard, durable pebbles or stone fragments, and a filler of finely crushed stone, sand or other finely divided mineral matter. Aggregate for gradings E-1, E-2 and E-3 shall consist of fine gravel and sand, disintegrated granite or other similar granular materials. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. The composite material shall meet the requirements for one of the gradings given next below, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1, Requirements for Grading of Aggregate.

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieves (A.A.S.H.O. T-27)				
	Grading A-1	Grading B-1	Grading C-1	Grading D-1	Grading E-1
1-inch	100	100	100	100	100
3/4-inch	75-100	75-100	85-100	85-100	85-100
No. 4	30- 45	40- 60	45- 65	50- 70	60- 95
No. 10	20- 35	25- 45	30- 50	35- 55	45- 80
No. 200	2- 7	3- 8	5- 10	5- 12	5- 15

TABLE 2, Requirements for Grading of Aggregate.

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieves (A.A.S.H.O. T-27)				
	Grading A-2	Grading B-2	Grading C-2	Grading D-2	Grading E-2
3/4-inch	100	100	100	100	100
No. 4	35- 50	45- 65	50- 70	55- 75	60- 95
No. 10	25- 40	30- 50	35- 55	40- 60	45- 80
No. 200	2- 7	3- 8	5- 10	5- 12	5- 15

TABLE 3, Requirements for Grading of Aggregate.

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieves (A.A.S.H.O. T-27)				
	Grading A-3	Grading B-3	Grading C-3	Grading D-3	Grading E-3
1/2-inch	100	100	100	100	100
No. 4	40- 55	50- 70	55- 75	60- 80	65-100
No. 10	30- 45	35- 55	40- 60	45- 65	50- 85
No. 200	2- 7	3- 8	5- 10	5- 12	5- 15

Aggregate shall be so graded within the limits given in tables 1, 2 and 3, that at least 10 per cent of the total aggregate shall pass a No. 4 sieve and be retained on a No. 10 sieve. No intermediate sizes of aggregate shall be removed for use in the seal coat or other purposes without the written consent of the engineer.

The above gradations represent the extreme limits which shall determine the suitability of aggregate for use. The final gradation decided on within the limits designated in the tables shall be uniformly graded from coarse to fine, and shall not vary from the low limits on one screen to the high limits on the adjacent screen, or vice versa.

The engineer may, when necessary to obtain a desired and uniform mixture, fix the maximum per cent of the mineral aggregate passing the No. 4 sieve within the specified limits and the contrac-

tor will not be allowed any claim for payment for cost for rejection of fines to conform to such maximum limits.

If crushed gravel is used, not less than 50 per cent by weight of the coarse aggregate particles shall have at least one fractured face.

Coarse aggregate shall have a percent of wear of not more than 40 at 500 revolutions, as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test), except that this requirement shall not apply to coarse aggregate for grading E-1, E-2 and E-3.

For all grading, that portion of the filler, including any blended filler, passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

The composite aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films of clay or other vegetable matter that will prevent a thorough coating with bituminous material. The aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water. The bituminized aggregate shall have a swell of not more than 1.5 per cent as determined by method 1 of A.A.S.H.O. Method T-101.

Additional filler for blending with aggregate at the mixing plant, if needed, shall be obtained from sources approved by the engineer. The material for such purpose shall be free from lumps, and shall not contain more than 15 per cent of material retained on a No. 4 sieve.

(b) Bituminous Material. The bituminous material shall be of the kind and grade stipulated in the plans or proposal form and shall conform to the requirements of Sections 33, 34, or 35 of these specifications.

The percentage of bituminous material, by weight, to be added to the aggregate shall be between 3-1/2 and 7 per cent of the weight of the dry aggregate. The exact percentage to be used shall be fixed by the engineer on the basis of preliminary laboratory tests and field sieve analysis of the aggregate furnished.

39.03 EQUIPMENT. (a) Mixing Plants. The plants shall be so designed, co-ordinated and operated as to produce a mixture within the job mix tolerances specified. Plants shall have a production capacity of not less than 500 tons of accepted mix per each 8 hours.

Scales for any weigh box or hopper may be either of the beam or springless dial type and shall be of a standard make and design, sensitive to 0.5 per cent of the maximum load. When of the beam type there shall be a separate beam with tell-tale indicator for each size aggregate and a tare beam for balancing the hopper. All weighing equipment shall be capable of easy adjustment of any working part that may get out of adjustment and shall be sealed prior to initial use, and as often thereafter as the engineer may deem necessary to insure accuracy.

The plant shall be provided with separate chambers for drying and mixing the constituents. The coarse and fine aggregates shall be roughly mixed and evenly fed to the drier so that a uniform production and a uniform temperature may be secured. Drying shall continue for a sufficient time and at a sufficiently high temperature to reduce the moisture content of the aggregate to not more than 1 per cent. At the completion of the mixing operations, as specified below, and also at the time of spreading the mixture on the roadbed, the amount of moisture in the aggregate shall not exceed that permitted in this paragraph. The drier shall be capable of preparing aggregate at a rate equal to the full rated capacity of the plant.

After leaving the drier, all aggregates shall be stored in such manner as to control the temperature within the limits prescribed for mixing and to prevent accumulation of moisture. Before use the aggregate shall be passed over a screen or screens so as to separate it into at least two sizes, which shall be stored in separate bins. One bin shall contain that portion of the material which would be retained on a No. 4 sieve and one bin shall contain that portion of the material which would pass a No. 4 sieve. If there is a carry-over of fine aggregate into the coarse aggregate bin it shall at no time exceed 8 per cent. If more than 8 per cent should be found to be present, the contents of the bin shall be completely withdrawn and rescreened. The two sizes shall later be combined in the proper proportions as directed at the time of mixing.

The size of the storage bins shall be so proportioned as to insure adequate storage of appropriate fractions of the aggregate and the compartments shall be so constructed as to prevent overflow of one size into a compartment used for another size. Each bin compartment shall be equipped with a discharge gate directly over the weighing hopper, gates on both bins and hopper being so constructed as to prevent leakage when closed.

The mixer may be of the twin-shaft pug-mill batch type or may be a continuous mixing twin pug-mill plant with suitable volumetric control of aggregate and bitumen to produce equal accuracy with a weight batch plant. If volumetric proportioning and continuous mixing equipment is used, such equipment shall have an established background of service, satisfactory to the engineer, in accomplishing the required graduation control of aggregates and uniformity of mix. If of the batch type, the mixer shall have a minimum batch capacity of 2500 pounds. In the pug-mills, the clearance of the blades from all fixed and moving parts shall not exceed 3/4 inch, and the mixer box, if not enclosed, shall be provided with suitable means to prevent loss of dust by dispersion. The batch type mixer shall be so constructed as to prevent leakage of contents until batch is to be discharged and shall be equipped with a lock timing device by means of which accurate control of the mixing cycle can be accomplished. The time of mixing shall be considered as the interval between the time the asphalt is spread on the aggregate and the time the same aggregate is discharged from the mixing unit.

Where the plants are located in any vicinity where dust may be objectionable or when dust interferes with the efficient operation

of the plant, proper housings, mixer covers or dust collecting systems shall be installed. Provision shall be made to waste the material so collected or to return it uniformly to the plant as the engineer may direct.

The plant shall be provided with a weighing hopper having sufficient capacity to hold the maximum amount of aggregate for one batch.

The asphalt bucket for weighing the asphalt cement shall have sufficient capacity to hold not less than 20 per cent of the weight of aggregate required for one batch. The specified temperature of the asphalt in the pipe lines, meters, weigh buckets, spray bars and other containers or flow lines shall be maintained by steam jackets, so designed that steam will not be introduced into the bituminous material, or by properly insulated electrical heating units, if approved by the engineer. The asphalt bucket shall be suspended on beam type scales equipped with a tell-tale so that the tare weight of the bucket will be shown for each weighing and the net weight of the asphalt cement measured accurately to within 1.0 per cent above or below the weight required. The bucket shall be so arranged that it will deliver the molten asphalt cement in a thin uniform sheet or in multiple streams the full width of the mixer or by equally adequate means in the case of a continuous mixer.

Melting kettles and hot storage tanks which deliver asphalt cement directly to the weigh bucket shall be equipped with means for positive control of asphalt temperature at all times and shall have a total capacity sufficient for not less than 10 hours run of the paving plant. Heating shall be accomplished by steam coils, electricity or other means such that no flame shall come into contact with the heating tank and so designed that steam will not be introduced into the material. A circulating system for the asphalt shall be provided, of adequate size to insure the proper and continuous circulation between storage tank and mixer during the entire operating period. All pipe lines and fittings shall be steam-jacketed or otherwise properly insulated to prevent heat loss. Storage tank capacity shall be sufficient for at least one days run.

An armored thermometer reading from 200 degrees F. to 400 degrees F. shall be fixed in the asphalt feed line at a suitable location near the discharge valve at the mixer unit. The plant shall be further equipped with an approved dial scale, mercury actuated thermometer, an electric pyrometer or other approved thermometric instrument so placed at the discharge chute of the dryer as to register automatically or indicate the temperature of the heated aggregate.

(b) Placing Equipment. Equipment for spreading mixtures containing cut-back asphalt shall consist of approved adjustable type spreader boxes or similar equipment. Blade graders of the self-powered type, with blades not less than 10 feet long, wheelbases of not less than 16 feet, weighing not less than 14,000 pounds each, and equipped with pneumatic tires, shall be used for laying, shaping and finishing mixtures containing cut-back asphalts.

When the specified bituminous material is 90+ asphaltic material or asphalt, grade 85-200, equipment for spreading, shaping and finishing shall consist of an approved self-contained power machine operating in such manner that no supplemental spreading, shaping or finishing will be required to provide a surface which will comply with the requirements for smoothness herein contained. This self-contained power machine may be used, at the option of the contractor, when the specified bituminous material is rapid-curing cut-back asphalt, but shall not be used when medium-curing cut-back asphalt is specified. Rollers for compacting the surface shall be of the self-propelled tandem type weighing not less than 8 tons each.

39.04 CONSTRUCTION METHODS. (a) Weather and Seasonal Limitations. Plant mix surfacing shall be constructed only between May 1st and September 15th and operations will be carried on only when the surface is dry, when the atmospheric temperature in the shade is above 60 degrees F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed in writing by the engineer.

(b) Preparation of Aggregate. If the moisture content of the aggregate is more than 1 per cent of the dry weight of the aggregate, the aggregate shall be dried before being conveyed to the plant bins for proportioning. The aggregate shall be screened into at least the two fractions noted above and conveyed into separate compartments ready for proportioning and mixing.

Additional filler, if required to meet the grading requirements, shall be proportioned and blended with the mineral aggregate before being screened into the separate compartments. Filler may be added to the aggregate at the mixing plant by pre-mixing it thoroughly with the other fine aggregates or by feeding it into either the hot or cold elevator. Spreading filler over the tops of the aggregate pits or dumping it into the hoppers at crushing plants will not be permitted.

(c) Preparation of Bituminous Mixture. Before being delivered to the road, the aggregate shall be mixed with the bituminous material at a central mixing plant. The dry aggregates, prepared as described above, shall be combined in the plant in the proportionate amounts of each fraction of aggregate required to meet the specified grading. Where a batching plant is used, the engineer shall determine the quantity of bituminous material for each batch. In any case, the bituminous material shall be measured or gaged and introduced into the mixer in the proportionate amount determined by the engineer and the temperature prescribed by the engineer for the particular material being used. When the bituminous material being used is 90+ asphaltic material or asphalt, grade 85-200, aggregate shall be introduced into the mixer at a temperature between 250 degrees F. and 325 degrees F. In no case shall aggregate be introduced into the mixer at a temperature of more than 25 degrees F. above the temperature of the bituminous material. Mixing shall continue for a period of at least 30 seconds after all ingredients are in the mixer and until a uniform mixture of unchanging appearance is obtained, with all the particles of aggregate thoroughly coated with liquid asphalt.

(d) Transportation and Delivery of Mixture. The mixture shall be transported from the mixing plant to the point of use in pneumatic-tired vehicles having tight bodies previously cleaned of all foreign materials. When directed by the engineer, each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect it from the weather. The bituminous mixture shall be delivered to the point of use at such temperature between 200 degrees F. and 325 degrees F. as the engineer may direct. When the mixture is being placed during warm weather and the engineer has determined that satisfactory results can be obtained at lower temperatures, he may direct that the mixture be mixed and delivered at lower temperatures than those specified above.

(e) Preparation of Subgrade. Surfacing shall not be placed until the subgrade has been brought to a smooth and well compacted condition, true to grade and cross-section and free from ruts and inequalities.

When the same contract provides for both the construction of a base course and the placing of plant-mixed surfacing thereon, the surface of the base course shall be shaped and compacted to the required grade and cross-section immediately before applying the prime coat and the plant-mixed surfacing, and full compensation for such preparation of the base shall be considered as included in the prices paid for the plant-mixed surfacing and no additional allowance will be made therefor.

When the contract provides for placing plant-mixed surfacing on existing traveled ways or bases not constructed under the same contract, the surface of the existing traveled ways or bases shall be prepared to receive the prime coat or paint binder and plant-mixed surfacing under either of the following methods, as may be specified in the special provisions or proposal forms.

Method No. 1 The surface of the existing traveled way or base shall be scarified, watered and rolled immediately prior to placing the prime coat and plant-mixed surfacing. If this method is used, the proposal form will contain an item for "Fine Grading Subgrade and Shoulders", and the work shall be done and payment therefor made in accordance with Section 25 of these specifications.

Method No. 2. The prime coat or paint binder shall first be applied and then a leveling course of plant-mixed surfacing shall be spread as directed by the engineer to such thickness as is necessary to level irregularities, dips, depressions, sags and excessive crown, and to provide a smooth base of uniform grade and cross-section, in order that the surface course of plant-mixed surfacing shall be of uniform thickness. Such leveling courses of plant-mixed surfacing shall not be placed more than one day in advance of placing the remainder of the plant-mixed courses. If this method is stipulated in the special provisions or proposal form, the plant-mixed surfacing spread as a leveling course as herein specified will be paid for at the contract unit prices paid for plant-mixed surfacing and no additional allowance will be made for spreading and leveling the material.

(f) Prime Coat. Immediately before applying the prime coat, the surface shall be cleaned of all dirt and loose materials by means of blowers or power brooms, supplemented by hand brooming if necessary. The surface to be primed shall be brought to a smooth and well compacted condition, true to grade and free from ruts and inequalities.

Bituminous material shall be applied by means of a distributor at the rate or rates directed by the engineer, which will usually be from 0.20 to 0.50 gallons per square yard, and at the temperature specified for the particular material being used. Any prescribed application may be divided into two applications to prevent flowing off the surface and additional bituminous material may be applied where surface conditions indicate it to be necessary, if the engineer so directs.

The surfaces of structures and trees adjacent to the area being treated shall be protected in such manner as to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

After the prime coat has been applied, it shall be left undisturbed for a period of not less than 24 hours. If the weather is cool, a longer period may be necessary and shall be observed if required by the engineer. Any excess bituminous material remaining on the surface shall be blotted with sand or other approved material before the surface is opened to any kind of traffic. The contractor shall maintain the primed surface until the surfacing or next course has been placed. Maintenance shall include spreading any additional sand or other approved material necessary to prevent adherence of the prime coat to the tires of vehicles using the surface, and patching any breaks in the primed surface with additional bituminous material. Any area of primed surface that has become fouled by traffic, or otherwise, shall be cleaned before paving is placed thereon.

(g) Spreading and Blade Finishing. Unless a self-contained power spreading and finishing machine is used, bituminous mixture shall be deposited by the spreading equipment specified on one side of the primed roadbed and to a uniform depth sufficient to obtain the required thickness of wearing course over the full width that the course will have when compacted. The material shall then be formed into a uniform windrow. Before the mixture is spread the engineer shall test the windrow for moisture. If the moisture content of the mixture is more than 1 per cent of the dry weight of aggregate, the contractor shall blade and reblade the material and allow it to dry out. If necessary, the material shall be harrowed or disked and all compressed masses of material broken up. No spreading shall be done when the base to be covered is wet, or prior to authorization by the engineer.

At the end of each day's work, or when work is interrupted by weather conditions, all mixture not completely spread shall be bladed into a windrow. It shall not be allowed to remain partially spread on the roadway over night, or until the resumption of work. When bituminous mixture containing rapid-curing cut-back asphalt is being

laid with a blade grader, care shall be taken that the laying is completed before the mixture hardens.

The mixed material shall be spread from the windrow to the required width by self-powered, pneumatic-tired blade meeting the requirements of Section 38.03 of these specifications. It shall be in successive layers. After approximately one-half of the material has been laid, the remaining material shall be windrowed and that already laid shall be rolled once and then planed with the blade grader to remove inequalities. The remaining material shall then be spread. During compaction, the surface shall be dragged or bladed as necessary to fill ruts and remove incipient corrugations or other irregularities. The intervals between placing successive layers shall be as directed by the engineer. In spreading the windrow, care shall be taken to prevent cutting into the underlying course. If necessary to prevent such cutting, a layer of the mixture approximately one-half inch thick shall be left at the bottom of the windrow.

(h) Machine Spreading and Finishing. When the self-contained power machine is used, placing and compaction of the bituminous mixture shall progress in sections of not more than 1 mile in length. The bituminous mixture shall be spread, shaped and finished with the power machine specified. The mixture shall be placed one-half width at a time. The 6-inch strip of the first half-width adjacent to the centerline of the road shall not be rolled until the second half-width has been placed. After the first width has been compacted, the second width shall be placed, finished and compacted as provided for the first width except that rolling shall be extended to include the 6 inches of the first width not previously compacted. Where machine spreading in two layers is indicated on the plans, the procedure herein described shall apply similarly to each layer.

(i) Rolling Finished Surface. After all layers have been placed to full width, the wearing surface shall be re-rolled. Rolling shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center, except that on superelevated curves rolling may progress from the lower to the upper edge. Blading shall continue during the rolling only if so directed by the engineer. Rolling shall continue until the surface is of uniform texture and degree of compaction and is true to grade and cross-section. Under no circumstances shall the center of the surface course be rolled first.

The completed surface, when ready for acceptance, shall be thoroughly compacted, smooth and true to grade and cross-section, and free from ruts, humps, depressions or irregularities. When a straightedge 10 feet long is laid on the finished surface and parallel with the centerline of the road, the surface shall vary in no place more than 1/8-inch from the lower edge of the straightedge.

(j) Shaping Edges. While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

(k) Seal Coat. If shown on the plans and called for in the bid schedule, and a seal coat of the type called for shall be applied

to the finished plant-mixed surface. In such event, the surface shall be open to traffic for at least 2 weeks before the seal coat is applied.

39.05 PROTECTION OF ROADWAY STRUCTURES AND TRAFFIC. Protection of roadway structures and traffic shall be done in accordance with Section 38.06 of these specifications.

39.06 METHOD OF MEASUREMENT. Asphaltic materials will be measured in accordance with Sections 33.03, 34.03, or 35.03, of these specifications.

The tonnage to be paid for shall be the number of tons of plant-mixed surfacing of the grading called for in the bid schedule and used in the accepted work, including mixture placed in authorized stockpiles. The bituminous treated material shall be weighed after mixing and no deduction shall be made for the weight of bituminous material in the mixture. The mixture shall be weighed on scales furnished by the contractor, or on public scales. If weighed on public scales, the contractor shall at his own expense furnish weigh-master's certificates to the engineer.

The proportioning of the aggregates and the liquid asphalt in the mix shall be weighed and determined by the plant scales. The actual weights of materials, except liquid asphalt, insofar as payment may be made, shall however, be determined by weighing on an approved type of platform scale which shall be furnished by the contractor, or on public scales as herein provided.

Prior to weighing or placing of any material, the quantities or porportions of which are to be determined by weight, all scales to be used in this connection shall be tested and sealed at the expense of the contractor prior to their use upon the project and as often thereafter as the engineer may deem necessary to insure their accuracy.

39.07 BASIS OF PAYMENT. Plant-mixed surfacing will be paid for at the price bid per ton for plant-mixed surfacing and at the price bid per gallon for liquid asphalt or for asphaltic cement, which prices and payments shall constitute full compensation for furnishing all labor, materials, tools and equipment and for doing all the work involved in preparing the subgrade except as provided herein, and placing the plant-mixed surfacing as above specified, including rolling of the same.

Prime coat will be paid for at the price per gallon for application of prime coat, which price and payment shall constitute full compensation for preparing the surface, furnishing all labor, materials, tools and equipment and doing all the work involved in applying the prime coat as above specified.

Stockpiled material will be paid for at the unit prices for surfacing material in place on the roadbed, which prices and payments shall constitute full compensation for preparing the stockpile sites and for hauling and placing the material in the stockpiles as above specified, and all incidental work connected herewith.

Seal coat oiling will be paid for as provided for under Section 40 of these specifications, or by the special provisions.

SECTION 40

SEAL COAT OILING

(With Cover Coat Material)

40.01 DESCRIPTION. This item shall consist of a single application of bituminous material on the prepared bituminous surface, followed by spreading cover coat material conforming to the plans and in accordance with these specifications.

40.02 MATERIALS. The bituminous material shall be of the grade and type called for in the proposal form or plans and shall conform to the specifications as set forth under Sections 33, 34, or 35.

The cover coat material shall meet the requirements as set forth under Sections 30 or 36, as indicated in the proposal form.

40.03 CONSTRUCTION METHODS - GENERAL. Seal coat operations shall not be started until, in the opinion of the engineer, the bituminous surface is thoroughly compacted by traffic and rolling, and all holes and breaks in the surface and edges are repaired. In no event, unless ordered in writing by the engineer, shall the seal coat be placed on newly constructed or reconditioned surfaces in less than 10 days after such surface has been laid.

40.04 APPLICATION OF BITUMINOUS MATERIAL. Immediately prior to applying the bituminous material, the surface shall be swept clean of all dust, dirt, sand or other objectionable material which might prevent complete coverage or bond between the bituminous material and the roadway surface, by means of a rotary power broom or blower, by hand sweeping, or both, as required. Following the cleaning of the roadway, the bituminous seal coat material of the grade and type specified, shall be applied by means of a pressure distributor of the type specified under "Road Mix Bituminous Surface Course", Section 38, and at the rate specified in the plans or as directed by the engineer. If the surface texture is such that the bituminous material penetrates too rapidly, the engineer may require a preliminary application of approximately 0.1 gallon per square yard of surface. Spreading equipment must be such as to permit spreading the bituminous material in a uniform unbroken coat over the area to be treated. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper and so that all sprays will operate properly over the entire length being treated. Care shall be taken that the application of bituminous material at the junction of spreads is not in excess of the specified amount and any excess existing shall be squeegeed from the surface by hand. Any skipped areas or recognized deficiencies shall be corrected by hand application and hand operated pressure devices or by other approved means.

No bituminous material shall be applied when the roadway surface is damp or wet, or when the atmospheric temperature, or the temperature of the oil mat to which the material is being applied is

less than 65 degrees F. Work shall not be started without consent of the engineer and shall be terminated at once in event of rain. No seal coating work shall be continued after dark.

40.05 APPLICATION OF COVER COAT MATERIAL. Immediately following the application of the bituminous material, cover coat material of clean, dry aggregate shall be spread at the rate of approximately 20 to 25 pounds per square yard of surface to be covered. The exact amount of cover coat material to be applied shall be determined by the engineer. Spreading shall be accomplished in such a manner that the tires of the trucks at no time are in contact with the uncovered and newly applied bituminous material.

Spreading of cover material shall be done with mechanical spreaders designed to give a uniform cover of material for the full width to which it is applied. Spreaders shall be so designed that the rate of cover is independent of the speed at which the unit is operated.

If weather or surface conditions make it necessary, the application of bituminous material shall be restricted to the area that can be covered by the cover coat material present in trucks. Sufficient cover coat material shall be available at all times to insure continuous cover coating operations.

Under no circumstances shall cover coat materials be applied to chilled, dried or partially dried bituminous material, nor shall the work be carried on during a wind of sufficient force to blow sand, dust or other foreign matter into the spread of bituminous material prior to the application of cover coat aggregate.

Immediately after cover coat aggregate is spread the surface shall be broomed lightly with approved push or drag brooms to insure an even distribution of the cover coat material and shall then be rolled with a self-propelled tandem or three-wheeled roller weighing not less than 6 nor more than 10 tons, until a smooth uniform surface is obtained. In lieu of this roller, a roller with pneumatic tires, meeting the approval of the engineer, may be used.

40.06 PROTECTION OF ROADWAY STRUCTURES AND TRAFFIC. All bridges, sign posts, guard fence and any other roadside structures shall be adequately protected from being discolored by splashing oil. Compensation for furnishing, erecting and removing such protection shall be included in the unit price bid for the application of the oil.

When the roadway is under traffic, the seal coat shall not be applied to more than one-half the width of the roadway at a time and, if directed by the engineer, it shall be placed on only one-third of the width of the roadway at a time. In either case, the remaining section of the roadway shall be kept clear and open for traffic.

In addition to the safety measures provided for under Sections 7.04 and 7.08 and under Section 38.06, the contractor will

be required to maintain two watchmen, one at each end of the work, and a pilot car and operator to lead and direct traffic through the work, at all times that work is in progress and for a period of 4 hours after the completion of any section. The object of this latter provision is to reduce the amount of whip-off due to fast traffic prior to the time the bituminous material has had an opportunity to set up and bond firmly to the cover material.

40.07 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. (a) Bituminous material will be measured as provided under paragraphs 33.03, 34.03 or 35.03.

(b) Cover coat material shall be measured as provided for in paragraphs 29.07 or 30.03.

(c) Rolling shall be measured as provided in Section 22 of these specifications.

40.08 BASIS OF PAYMENT. (a) Bituminous material and application thereof shall be paid for as provided in paragraphs 33.04, 34.04, or 35.04.

(b) Cover coat material shall be paid for as provided in paragraphs 29.08 or 30.04.

(c) Rolling shall be paid for as provided in Section 22 of these specifications.

SECTION 41

SEAL COAT OILING

(Without Cover Coat Material)

41.01 DESCRIPTION. This item shall consist of applying the specified grade, type and amount of bituminous material to the completed surface.

41.02 MATERIALS. The bituminous material shall be of the grade and type as specified on the plans or in the proposal form or special provisions and shall conform to the specifications as set forth under Sections 33, 34, or 35.

41.03 CONSTRUCTION METHODS. All vegetable matter, paper, dust or other obstructions which might prevent a complete coverage or bond between the bituminous material and the roadway shall be swept or cleaned from the roadway surface with an approved type power broom, or by hand sweeping, or both, as required. Following the cleaning of the roadway the bituminous seal coat material of the grade and type specified shall be applied in the amount designated by the engineer. Application shall be made by means of a pressure distributor of the type specified under "Road Mix Bituminous Surface Course," Section 38, and at the rate specified in the plans or as directed by the engineer.

No bituminous material shall be applied when the roadway surface is damp or wet.

The State reserves the right to omit the seal coat if, in the opinion of the engineer, it is not required.

41.04 PROTECTION OF ROADWAY STRUCTURES AND TRAFFIC. All bridges, sign posts, guard fence and any other roadside structures shall be adequately protected from being discolored by splashing oil. Compensation for furnishing, erecting and removing such protection shall be included in the unit price bid for the application of the oil.

When the roadway is under traffic, the seal coat shall not be applied to more than one-half the width of the roadway at a time and if directed by the engineer, it shall be placed on only one-third of the width of the roadway at a time. In either case, the remaining section of the roadway shall be kept clear and open for traffic.

In addition to the safety measures provided for under Sections 7.07 and 7.08, the contractor will be required to maintain two watchmen, one at each end of the work, and a pilot car and operator to lead and direct traffic thru the work, at all times work is in progress and for such time after the completion of each days work as may be required for the seal to dry sufficiently to obviate pickup of the seal under traffic.

41.05 METHOD OF MEASUREMENT. Bituminous material will be measured as provided under paragraphs 33.03, 34.03 or 35.03.

41.06 BASIS OF PAYMENT. Bituminous material and application thereof shall be paid for as provided in paragraphs 33.04, 34.04 or 35.04.

SECTION 42

BITUMINOUS TREATMENT OF ROADWAY SHOULDERS

42.01 DESCRIPTION. This item shall consist of the placement, compaction and bituminous treatment of gravel material on the shoulders of the roadway from the limits of the oil mat out to the shoulders edge. If the contract provides for the placing of top course surfacing then the furnishing, placing and compacting of the shoulder material shall be included in the item for "Rock or Gravel Surface Courses," Section 29, and the application of the bituminous seal and cover material shall be included in the quantities for "Seal Coat Oiling," Section 41.

42.02 MATERIALS. The mineral aggregate used shall be of the type as specified on the plans and in the proposal form and shall conform to the specification for that particular type aggregate as set forth under Sections 29 or 30.

Bituminous material, to be supplied by the contractor, shall be of the grades as specified on the plans and in the proposal form and shall conform to the specifications for the particular grades as set forth under Sections 33, 34 or 35.

42.03 CONSTRUCTION METHODS. Following placement of the oil mat to the design as required by the plans, the shoulder material shall be spread to line and grade. The shoulder material may be windrowed on either shoulder prior to the mixing of the oil mat or it may be placed on the shoulders after completion of the oil mat, using a spreader box or other approved means to secure a uniform distribution of material. The material shall then be spread and compacted by rolling, adding water if necessary to secure proper compaction. After compacting, the shoulder surface shall form a smooth, uniform continuation of the mat surface with no depressions or unfilled areas at the junction of the oil mat and the gravel shoulder.

When compacted, the shoulders shall be swept with a road broom of approved design until they are free of dust and all loose particles and a clean firm surface is produced. Sweeping shall be performed so that all loose material shall be swept directly and completely over the adjacent shoulder edge.

Where the shoulders to be treated have been placed under previous contract, and in the judgment of the engineer, are not sufficiently or properly compacted, or are otherwise in an unsuitable condition, they shall be smoothed, watered, if necessary, and rolled as required prior to the placing of the treatment.

Following the sweeping, a prime coat of the specified grade of bituminous material shall be applied upon the untreated surface at the rate of 0.3 gallon per square yard or as directed by the engineer.

After the primed surface has been permitted to cure not less than 3 days nor more than 10, an application of bituminous mater-

ial of the grade specified for the second application shall be applied at the rate of 0.25 to 0.40 gallon per square yard or as directed by the engineer, care being taken that this material is applied so that it will extend well upon the sloping edge of the oil mat and well over the shoulder edge.

Immediately following the second application of bituminous material, stone chips, or Type "A" crushed gravel or stone, as required by the plans and in the proposal form, in the amount specified by the engineer, shall be spread upon the section. The aggregate shall be spread uniformly and smoothly to the required thickness by brooming the surface lightly with approved push or drag brooms, and immediately rolled to the extent required by the engineer; in any event, not more than two complete trips over each shoulder section shall be made.

42.04 METHOD OF MEASUREMENT. (a) The asphaltic road oil or cutback asphalt shall be measured by the U. S. gallon measured at a temperature of 60 degrees F., or corrected to this basis as prescribed in the standards of the American Society for Testing Materials, Serial Designation D 206. The quantity in each car or truck tank shall be determined from the producer's invoice, checked by the engineer in the field.

(b) Application of oil shall be measured by the U. S. gallon, the measurement being made as herein provided in paragraph (a).

(c) Crushed gravel or surfacing or cover material of the grades specified shall be measured by the ton or cubic yard as called for in the plans, special provisions or proposal forms and shall be measured in accordance with Sections 29 or 30.

(d) Watering, if required will be measured by the one thousand U. S. gallons in accordance with Section 21.

(e) Rolling will be paid for as provided in Section 22 of these specifications.

42.05 BASIS OF PAYMENT. Payment for bituminous treatment of roadway shoulders shall be made as follows: (a) Application of oil shall be paid for at the contract unit bid price per gallon, which price and payment shall include all demurrage, storage, handling and other charges, all materials (including the road oil), tools, equipment and labor, and the performance of all work necessary or incidental to the furnishing, delivering, unloading, heating, hauling, and spreading of the oil.

(b) Crushed gravel surfacing or cover material shall be paid for at the contract unit price bid per ton or per cubic yard as called for on the proposal form.

(c) Watering, if included in the bid schedule, shall be paid for as provided in Section 21.

(d) Rolling shall be paid for as provided in Section 22 of these specifications.

The cost of any necessary shaping or smoothing of shoulders prior to the placing of the bituminous shoulder treatment shall be included in other bid items and no additional payment shall be made therefor.

DIVISION II

CONSTRUCTION DETAILS

PART III – STRUCTURES

DIVISION II

CONSTRUCTION DETAILS

Part III -- STRUCTURES

SECTION 43

REMOVAL OF EXISTING STRUCTURES

43.01 DESCRIPTION. This item shall consist of the removal and satisfactory disposal of all portions of existing structures, except such portions as may be required or permitted to be left in place by these specifications, the plans, or the special provisions, and also the maintenance of traffic and all other operations specified in this section.

43.02 REMOVAL OF SUPERSTRUCTURES. Portions of steel or timber superstructures required to be salvaged shall be dismantled, handled and stored in such manner as to avoid any unnecessary damage to any member thereof. Concrete and masonry superstructures shall be removed and disposed of as provided in Section 43.04 unless otherwise specified.

All members shall be match-marked with paint before they are dismantled. All pins, nuts, loose plates, etc., shall be similarly marked to indicate their proper location; all pins, pin holes, and machined surfaces shall be painted with a mixture of white lead and tallow and all loose parts shall be wired to adjacent members or packed in boxes with contents clearly marked thereon or index numbered for future identification.

43.03 REMOVAL OF SUBSTRUCTURES. Unless otherwise specified or ordered by the engineer, all portions of the substructures of existing structures above the bed of the stream, finished ground surface, or ground surface as it existed before the work was started, and all portions below the bed of the stream or ground surface which interfere in any way with the new construction, shall be removed. Blasting or other operations which might endanger the new work shall be completed prior to the construction of any part of the new structure.

Where piles compose the substructure, or a part thereof, the contractor shall cut off the piles one foot below the finished ground surface or pull them, as he prefers. However, if they interfere with the new construction, he shall remove them completely.

The substructures for temporary bridges shall be removed as required herein for the substructures of existing structures.

43.04 DISPOSAL OF MATERIALS REMOVED. (a) Structural Steel. Structural steel members removed from the old structures shall, unless otherwise specified or directed, be stored in a neat and presentable manner in locations designated by the engineer, within the right of way and adjacent to the site of the work. Members of structures which are to be re-erected and all steel beams shall be

stored above the ground surface on skids or otherwise protected as directed by the engineer.

(b) Concrete and Masonry. Concrete and masonry which is removed from old structures, shall, as far as practicable, be placed in backfills or approach embankments or shall be used to riprap the slopes of the embankments or the channel if specified on the plans. Any concrete or masonry which cannot be placed in backfills or embankments or used as riprap shall be disposed of as directed by the engineer and in such manner as to prevent damage to property or the creation of unsightly conditions.

(c) Timber and Other Materials. All timber and other materials having salvage value shall be piled up in a neat and presentable manner on skids above ground in locations designated by the engineer, within the right of way and adjacent to the site of the work.

(d) Ownership of Materials Removed. All materials having salvage value shall be disposed of as provided herein and shall be considered the property of the State. Written permission to use any of these materials in the contractor's operations shall be secured from the engineer.

43.05 DISPOSAL OF TEMPORARY STRUCTURES, CLEANING SITES, ETC. Upon the completion of the new structures, with the necessary backfilling and roadway embankments, the contractor shall remove and dispose of any temporary structure he may have installed in connection with the maintenance of traffic, to the satisfaction of the engineer; and, furthermore, he shall leave the adjacent premises in such condition as to present neat and acceptable appearances.

43.06 BASIS OF PAYMENT. If the contract contains a separate item and price for "Removing Existing Structures and Maintaining Traffic", such price shall be payment in full for the removal and disposal of the existing structures, maintenance of traffic, and all other operations specified in this section.

If the contract does not contain a separate item and price for "Removing Existing Structures and Maintaining Traffic", payment in full for the work specified in this section shall be considered as included in the contract unit prices for the various items of the contract.

SECTION 44

CONCRETE BRIDGES

44.01 DESCRIPTION. This item shall consist of concrete bridges and the concrete portions of steel, timber and composite bridges, constructed in conformity with the plans or as ordered in writing by the engineer, and in accordance with this and other specification items involved.

44.02 MATERIALS. All materials used shall be those prescribed for the several items which constitute the structure.

44.03 METHOD OF CONSTRUCTION. (a) Foundations. All foundations shall be prepared as specified under Section 48, "Excavation for Structures", and they shall be inspected and approved by the engineer previous to placing any concrete.

(b) Drains. Drains and waterstops shall be constructed as shown on plans or as directed by the engineer.

(c) Placing Concrete. Concrete shall be placed in accordance with the requirements hereinafter specified in Section 49.05 (g).

(d) Falsework and centering. Unless otherwise provided, detailed plans for falsework or centering shall be supplied to the engineer upon request, but in no case shall the contractor be relieved of responsibility for results obtained by the use of these plans.

Arch centering shall be constructed according to centering plans approved by the engineer. Provision shall be made by means of suitable wedges or jacks for the gradual adjustment and release of falsework or centering supports. Supplemental sand boxes or other approved devices may be used for lowering arch centering.

No falsework or centering supports shall be removed unless removal meets with approval of the engineer. In general, falsework or centers shall be struck before coping or railing forms are erected. This precaution is essential in multiple spans to avoid joining of expansion joints and to provide for variations in alignment and camber. For filled spandrel arches, such portions of the spandrel walls shall be left for construction subsequent to the striking of centers as may be necessary to avoid jamming of the expansion joints.

Falsework or centers shall be gradually and uniformly lowered in such a manner as to avoid stresses in any part of the structure. In structures of two or more spans, the sequence of striking falsework or centers shall be specified or approved by the engineer.

44.04 METHOD OF MEASUREMENT. The quantities of the various items which constitute the completed and accepted structure shall be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing by the engineer.

44.05 BASIS OF PAYMENT. The measured quantities as provided above, shall be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all materials, and for labor, equipment, tools, drains, waterstops and necessary incidentals. Such payment shall constitute full compensation for the completed structure, ready for use, and no additional allowance will be made for cofferdam construction, falsework, form lumber, or other erection expenses.

SECTION 45

STEEL BRIDGES

45.01 DESCRIPTION. This item shall consist of steel bridges, including but not limited to superstructures to be placed on concrete, masonry, steel or timber substructures, constructed in conformity with the plans or as ordered in writing by the engineer, and in accordance with this and other specification items involved.

45.02 MATERIALS. All materials used shall be those prescribed for the several items which constitute the structure.

45.03 FOUNDATIONS. All excavation for foundations and substructures shall be performed as specified in Section 48, "Excavation for Structures."

45.04 PLACING CONCRETE. All concrete shall be placed and finished as specified in Section 49, "Concrete."

45.05 FABRICATION. Structural steel shall be fabricated in accordance with the following requirements:

(1) Drawings. The construction plans shall consist of shop details, erection and other working plans showing details, dimensions, size of material and other information and data necessary for the complete fabrication and erection of the metal work. Approval of construction plans by the engineer shall be secured before fabrication of steel work is commenced.

The contractor shall furnish the engineer with prints of the shop drawings in quadruplicate for approval, and after approval he shall furnish three or more prints, as required, of the approved drawings. All shop drawings shall be 22" x 36" with a 1-1/2" margin on the left side and a 1/2" margin on the other three sides. Upon completion of the work the original tracings, if required, shall be supplied to the engineer. No deviation from the approved plans shall be permitted without a written order from the engineer.

Changes on approved drawings shall be subject to the approval of the engineer, and he shall be supplied with a record of such changes.

Substitutions of sections different from those shown on the drawings shall be made only when approved in writing by the engineer.

(2) Workmanship and Finish. The workmanship and finish shall be equal to the best practice in modern bridge shops. Shearing, flame cutting and chipping shall be neatly and accurately done and all portions of the work exposed to view shall be neatly finished.

(3) Storage of Materials. Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease or other foreign matter, and shall be protected as far as practicable from corrosion.

(4) Straightening Materials. Rolled material before being laid out or worked must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends may be cause for rejection of the material.

(5) Punched Work. If general reaming is not required, all material, forming parts of a member composed of not more than five thicknesses of metal, may be punched with a punch 1/16 inch larger than the nominal size of the rivets, whenever the thickness of the metal is not greater than three-fourths inch. When there are more than five thicknesses, or when any of the material is thicker than three-fourths inch, all of the holes shall be punched with a punch 3/16 inch smaller and after assembling reamed 1/16 inch larger than the nominal size of the rivets, except that when the metal is thicker than the size of the rivet, the holes shall be drilled.

(6) Punched Holes. Holes punched full-size shall be 1/16 inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than 3/32 inch. Holes shall be clean cut and without torn or ragged edges.

(7) Accuracy of Punched Holes. The punching of holes shall be done so accurately that, after assembling the component parts of a member, a cylindrical pin 1/8 inch smaller than the nominal diameter of the punched hole may be passed through at least 75 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes. If this requirement is not fulfilled, the badly punched pieces may be rejected. If 10 per cent of any group of 100 or fewer holes will not pass a pin 3/16 inch smaller than the nominal diameter of the punched holes, the mispunched pieces may be rejected.

(8) Reamed Work. General reaming will be required if provided for in the contract.

If general reaming is required, holes shall be sub-punched and reamed in material forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes may be punched full-size in material used for lateral, longitudinal and sway bracing, lacing bars, stay plates, and diaphragms, not forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes shall be drilled in material the thickness of which is greater than the nominal diameter of the rivet.

(9) Sub-Punched Holes. Sub-punched and reamed holes for rivets having diameters greater than 3/4 inch shall be punched 3/16 inch smaller than the nominal diameter of the rivet. For rivets having diameters of 3/4 inch, the holes shall be punched 11/16 inch in diameter. For rivets having diameters of 5/8 or less, the holes shall be punched full size and spear-reamed. The punch and die shall have the same relative size as specified for full size punched holes.

(10) Reaming. After assembling, sub-punched holes shall be reamed to a diameter 1/16 inch larger than the nominal diameter of the rivet.

Reaming shall be done after the pieces forming a built member are assembled and firmly bolted together. Reamed parts shall not be interchanged.

Reaming of rivet holes shall be done with twist drills or with short taper reamers. Reamers preferably shall not be directed by hand. If oil or grease is used as a lubricant when reaming, it shall be applied so as not to soil the surfaces which are to be painted. Burrs resulting from reaming shall be removed.

(11) Drilled Holes. Drilled holes shall be 1/16 inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed. If members are drilled while assembled, the parts shall be held securely together while the drilling is being done.

(12) Accuracy of Reamed and Drilled Holes. Reamed or drilled holes shall be cylindrical and perpendicular to the member. After reaming or drilling, 85 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes, shall not show an offset greater than 1/32 inch between adjacent thicknesses of metal.

(13) Shop Assembling. Surfaces of metal in contact shall be cleaned before assembling.

The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operations. The member shall be free from twists, bends, and other deformation.

Preparatory to the shop riveting of full-size punched material, the rivet holes, if necessary, shall be spear-reamed for the admission of the rivets. The reamed holes shall not be more than 3/32 inch larger than the nominal diameter of the rivets.

End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct position and bolted, clamped, or otherwise firmly held in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts insofar as practicable to prevent damage in shipment and handling.

(14) Drifting of Holes. The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit rivets, they shall be reamed.

(15) Reaming of Field Connections. If general reaming is required, riveted trusses, skew portals, rigid frames, spliced girders,

columns and beams shall be assembled in the shop, the parts adjusted to line and fit, and holes for field connections drilled or reamed while so assembled. Holes for other field connections, except those in lateral, longitudinal, and sway bracing, shall be drilled or reamed in the shop with the connecting parts assembled, or else drilled or reamed to a metal template without assembling.

If provided in the contract, the field connections in punched work, except those for lateral, longitudinal and sway bracing shall be reamed to a metal template or else with the parts assembled.

(16) Match-Marking. Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the engineer.

(17) Field Rivets. Field rivets shall be furnished in excess of the nominal number required to the amount of 10 per cent plus 10 rivets for each diameter and length.

(18) Field Bolts. Bolted connections shall not be used unless specifically authorized. If bolted connections are permitted, the bolts shall be unfinished bolts or turned bolts, as specified. Bolts shall have hexagonal heads and nuts, and shall be of such length that they will extend entirely through the nut but not more than 1/4 inch beyond. Bolts in tension shall have 2 nuts.

Unfinished bolts in shear shall have not more than 1 thread within the grip. The diameter of the unfinished bolts shall not be more than 1/16 inch smaller than the diameter of the hole.

The threads of turned bolts shall be entirely outside the grip. The bolts shall be given a finishing cut. Approved nut locks or flat washers 1/4 inch thick shall be furnished, as specified. The holes for turned bolts shall be reamed and their diameters shall be not more than 1/32 inch greater than the diameter of the finished bolt.

Special types of lock bolts may be used with the written approval of the engineer.

(19) Riveting. Rivets, before driving, shall be of the diameter specified. Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. Rivets, when heated and ready for driving, shall be free from slag, scale, and other adhering matter. When driven, they shall completely fill the holes. The heads shall be of approved shape, full size, neatly formed, concentric with the shank, free from fins, and in full contact with the surface of the member.

Loose, burned or otherwise defective rivets shall be replaced. In removing rivets, care should be taken not to injure the adjacent metal, and, if necessary, they shall be drilled out. Caulking or re-cupping will not be permitted.

Rivets shall be driven by direct-acting riveters where prac-

ticable. The riveters shall retain the pressure after the upsetting is completed. If rivets are driven with a pneumatic hammer, a pneumatic bucker shall be used if practicable.

(20) Edge Planing. Sheared edges of plates more than 5/8 inch in thickness and carrying calculated stress shall be planed to a depth of 1/4 inch. Re-entrant cuts shall be filleted before cutting.

(21) Flame cutting. Steel or wrought-iron may be flame cut, provided a smooth surface is secured by the use of a mechanical guide. Flame cutting by hand shall be done only where approved by the engineer and the surface shall be made smooth by planing, chipping or grinding. The cutting flame shall be so adjusted and manipulated as to avoid cutting beyond the prescribed lines. Re-entrant cuts shall be filleted.

(22) Facing of Bearing Surfaces. The top and bottom surfaces of steel slabs and base plates and cap plates of columns and pedestals shall be planed, or else the plates or slabs hot straightened. Parts of members in contact with them shall be faced.

Sole plates of beams and girders shall have full contact with the flanges. Sole plates and masonry plates shall be planed or hot straightened. Cast pedestals shall be planed on surfaces to be in contact with steel and shall have the surface to be in contact with masonry rough finished.

Surfaces of bronze bearing plates intended for sliding contact shall be finished.

In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of the expansion.

(23) Abutting Joints. Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed 1/8 inch.

(24) End Connection Angles. Floorbeams, stringers, and girders having end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall be not less than that shown on the detail drawings.

(25) Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

(26) Finished Members. Finished members shall be true to line and free from twists, bends and open joints.

(27) Web Plates. In girders having no coverplates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than 1/8 inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be 1/2 inch less in width than the distance back-to-back of flange angles.

At web splices, the clearance between the ends of the web plates shall not exceed 3/8 inch. The clearance at the top and bottom ends of web splice plates shall not exceed 1/4 inch.

(28) Fit of Stiffeners. End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within 1/4 inch at each end. Welding will be permitted in lieu of milling or grinding if noted on the plans or specified in the special provisions.

(29) Eye-Bars. Eye-bars shall be straight, true to size, and free from twists, folds in the neck and head and other defects. The heads shall be made by upsetting and rolling or forging, and not by welding. The form of the heads will be determined by the dies in use at the works where the eye-bars are made, if they are satisfactory to the engineer. The thickness of the head and neck shall not over-run more than 1/16 inch.

Eye-bars that are to be placed side by side in the structure shall be bored so accurately that upon being placed together, pins 1/32 inch less in diameter than the pin holes will pass through the holes at both ends at the same time without driving.

(30) Annealing. Before boring, eye-bars shall be annealed to produce the required physical qualities and shall be straightened. Proper instruments shall be provided for determining at any time the temperature of the bars.

Other steel that has been heated partially shall be annealed, unless it is to be used in minor parts. Crimped stiffeners need not be annealed.

(31) Pins and Rollers. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. The final surface shall be produced by a finishing cut.

Pins more than 7 inches in diameter shall be forged and annealed.

In pins larger than 9 inches in diameter, a hole not less than 2 inches in diameter shall be bored full length along the axis.

(32) Boring Pin Holes. Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside-to-outside of holes in tension members and inside-to-inside of holes in compression members shall not vary from that specified more than 1/32 inch. Boring of holes in built up members shall be done after the riveting is completed.

(33) Pin Clearances. The diameter of the pin hole shall not exceed that of the pin by more than 1/50 inch for pins 5 inches or less in diameter, or 1/32 inch for larger pins.

(34) Welds. All welding, unless otherwise specified, shall be done by the electric arc process, in accordance with the American Welding Society Specifications with subsequent amendments and additions thereto adopted by the Society.

(35) Screw Threads. Screw threads shall make close fits in the nuts and shall be American National Coarse Thread Series 2, except that for pin ends of diameters greater than 1-1/2 inches, they shall be made with six threads to the inch.

(36) Pilot and Driving Nuts. One pilot nut and one driving nut for each size pin shall be furnished, unless otherwise specified.

(37) Upset Ends. Bars with screw ends shall be upset so that the area at the root of the thread will be at least 15 per cent larger than in the body of the bar. Closed sleeve nuts shall not be used.

45.06 MILL AND SHOP INSPECTION. Materials are subject to inspection as specified in Section 51, "Structural Steel."

45.07 MARKING AND SHIPPING. (a) Marking and Shipping. Members weighing more than 3 tons shall have the weight marked thereon. Bolts and rivets of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts, and small packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs, or barrels, but the gross weight of any package shall not exceed 300 pounds. A list and description of the contained material shall be plainly marked on the outside of each package.

Anchor bolts, washers, and other anchorage or grillage materials, shall be shipped in time to suit the requirements of the masonry construction.

(b) Handling Material. The loading, transportation, unloading, and storing of structural material shall be conducted so that the metal will be kept clean and free from injury.

45.08 ERECTION. The contractor shall erect the metal work, remove the temporary construction, and do all the work required to complete the bridge or bridges as covered by the contract, including the removal of the old structure or structures, if stipulated, all in accordance with the plans and these specifications.

(a) Masonry. If the substructure and superstructure are built under separate contracts, the State will provide the masonry, constructed to correct lines and elevations and properly finished, and will establish the lines and elevations required for setting the steel.

(b) Plant. The contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and fitting-up bolts, necessary for the expeditious handling of the work. Temporary structures or falsework placed by the purchaser, if suitable, may be used by the contractor.

(c) Handling and Storing Materials. Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. The contractor shall check the material turned over to him against the shipping lists and report promptly in writing any shortage or injury discovered. He shall be responsible for the loss of any material while in his care, or for any damage resulting from his work.

(d) Falsework. The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The contractor, if required, shall prepare and submit to the engineer for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the Contractor's plans shall not be considered as relieving the contractor of any responsibility.

(e) Methods and Equipment. Before starting work, the contractor shall inform the engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the engineer. The approval of the engineer shall not be considered as relieving the contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the sanction of the engineer.

(f) Bearing and Anchorage. Masonry bearing plates shall not be placed upon bridge-seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed by the engineer, they shall be placed on a layer of canvas and red lead applied as follows:

Thoroughly swab the bridge-seat bearing area with red lead paint and place upon it three layers of 12 to 14 ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place the superstructure shoes or pedestals in position while the paint is plastic.

In setting shoes or bearing plates for steel truss spans proper allowances shall be made for bottom chord elongation due to dead load.

Anchor bolt holes shall be drilled in the correct locations or may be formed by the insertion in fresh concrete of oiled wooden plugs, metal pipe sleeves or other approved devices which are subsequently withdrawn after the concrete has partially set. If the holes are drilled the anchor bolts shall first be dropped into the dry holes to assure their proper fit after setting. If the holes are correct the bolts shall then be removed and the holes shall be filled about 2/3 full of Portland cement grout and by a uniform, even pressure or by light blows with a hammer (flogging and ramming will not be permitted) force the bolt down until the grout rises to

the top of the hole and the anchor bolt nut rests firmly against the metal shoe or pedestal. When the holes are formed by the latter method, they shall be not less than 4 inches in diameter to allow for horizontal adjustment of the bolts. The exact location of the anchor bolts shall then be determined and the anchor bolts shall be grouted in the holes with Portland cement grout. All excess grout shall be removed in order to permit proper painting of metal surfaces.

In lieu of the above specified methods of placing anchor bolts, they may be set to exact location in the concrete when it is placed. If this method is used great care shall be exercised to insure the proper setting of the bolts and any inaccuracies which will be detrimental to the structure shall be corrected by a means approved by the engineer.

The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span.

(g) Straightening Bent Material. The straightening of plates and angles or other shapes shall be done by methods not likely to produce fractures or other injury. The metal shall not be heated unless permitted by the engineer, in which case the heating shall not be to a higher temperature than that producing a dark cherry-red color. After heating, the metal shall be cooled as slowly as possible.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

(h) Assembling Steel. The parts shall be accurately assembled as shown on the plans and any match-marks shall be followed. The material shall be carefully handled so that no part will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members shall not be driven until the span has been swung. Rivets in railings shall not be driven until the span has been swung and the deck placed. Splices and field connections shall have 1/2 of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have 3/4 of the holes so filled.

Fitting up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be 1/16 inch larger.

(i) Riveting. Pneumatic hammers shall be used for field riveting, except when the use of hand tools is permitted by the engineer. Rivets larger than 7/8 inch in diameter shall not be

driven by hand. Cup-faced dollies, fitting the head closely to insure good bearing, shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank, and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or re-cupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out. Field driven rivets shall be inspected and accepted before being painted.

(j) Bolted Connections. In bolted connections, the bolts shall be drawn up tight and the threads burred at the face of the nut with a pointed tool.

(k) Pin Connections. Pilot and driving nuts shall be used in driving pins. They shall be furnished with the steel work and shall be returned to the State on completion of the work. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

(l) Misfits. Corrections of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered a legitimate part of the erection. Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the inspector, and his approval of the method of correction obtained. The correction shall be made in the presence of the inspector, who will check the work and material. The contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements.

(m) Removal of Old Structure and Falsework. If stipulated in the contract, the contractor shall dismantle the old structure and dispose of it as stipulated in these specifications, Section 43, "Removal of Existing Structures."

Upon completion, and before final acceptance, the contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged, and restore in acceptable manner all property, both public and private, which may have been damaged during the prosecution of his work, and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the engineer. All falsework piling shall be pulled or cut off 1 foot below finished ground line where conditions will permit. If conditions are not favorable for pulling or cutting off the piles as stated above, the piles shall be either broken or shot off at the stream bed, unless otherwise provided by the engineer. All excavated material or falsework

placed in the stream channel during construction shall be removed by the contractor before final acceptance.

(n) Inspection. The work shall be subject at all times to inspection by the engineer.

45.09 LAWS AND PERMITS. The contractor shall comply with Federal, State and local laws, regulations, and ordinances, and shall obtain, at his own expense, the necessary permits for his operations.

45.10 PAINTING. (a) General. The painting of metal structures shall include, unless otherwise provided in the contract, the proper preparation of the metal surfaces, the application, protection and drying of the paint coatings, the protection of pedestrian, vehicular or other traffic upon or underneath the bridge structure, the protection of all portions of the structure (superstructure and substructure) against disfigurement by spatters, splashes and smirches of paint or of paint materials, and the supplying of all tools, tackle, scaffolding, labor, workmanship and materials necessary for the entire work.

(b) Application. All new structural steel work shall, unless otherwise especially provided upon the plans or in the contract, be given three coats of paint. The painting shall be done in a neat and workmanlike manner. Paint shall be applied in full coats, either with brushes or spray, so that every part of the surface is completely covered.

When paint is applied with brushes the paint shall be so manipulated under the brush as to procure a uniform, even coat in close contact with the metal or with previously applied paint. In general, the primary movement of the brush shall describe a series of small circles to thoroughly fill all irregularities in the surface, after which the coating shall be brushed out and smoothed by a series of parallel strokes until the paint film has an even thickness. Brushes preferably shall be round or oval in shape, but if flat brushes are used they shall not exceed 4 inches in width.

If spraying equipment is employed, it shall be of a type that will insure a satisfactory application of the paint specified. When spraying is used, the pressure tank shall have an agitator to keep the paint thoroughly stirred.

The paint shall be thoroughly stirred previously by means of approved mechanical mixers before being removed from the containers, and the pigments shall be kept in suspension by stirring during the application. When the quantity of each coat of paint required is 5 gallons or less, the engineer may, at his discretion, approve hand mixing.

If it is necessary in cool weather to thin the paint in order that it may spread more freely, such thinning shall be done only by heating in hot water or on steam radiators.

On all surfaces which are inaccesible for paint brushes, the paint shall be applied with spray or sheepskin daubers especially

constructed for the purpose.

Paint shall be applied only when the air temperature is at or above 40 degrees F. It shall not be applied upon damp surfaces or upon metal containing frost, nor shall it be applied when the air is misty or when, in the opinion of the engineer, conditions are unsatisfactory for the work.

Materials painted under cover in damp or cool weather shall remain under cover until dry or until weather conditions permit their exposure in the open. Painting shall not be done when the metal is hot enough to cause the paint to blister and produce a porous paint film.

The contractor shall be responsible for the satisfactory application of paint, and neither weather conditions nor the laboratory acceptance of the materials used in the paint shall relieve him of the responsibility of obtaining a satisfactory paint job. If, in the opinion of the engineer, the painting is unsatisfactory, the paint shall be removed and the metal thoroughly cleaned and repainted. No additional allowance will be made because of any expense incurred because of these requirements.

(c) Cleaning. Surfaces of metal to be painted shall be thoroughly cleaned, removing rust, loose mill or welding scale, dirt, oil or grease, and other foreign substances. The removal of rust, scale, and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers, sand blasting, flame cleaning, or other effective means. Oil and grease shall be removed by the use of gasoline or benzine. Bristle brushes shall be used for removing loose dust.

(d) Shop Paint. All metal surfaces, except surfaces to be in contact after erection, shall receive one coat of red lead paint meeting the requirements of shop coat set forth elsewhere in these specifications, unless otherwise specified herein or in the contract. The shop coat shall be applied immediately after fabrication, shop inspection and shop cleaning have been completed and the work has been accepted. Metal surfaces to be in contact after erection shall not be painted. Material shall not be loaded for shipment until the paint is dry.

Erection marks for the field identification of members shall be painted on painted surfaces.

With the exception of abutting chord and column splices and column and truss shoe bases, machine-finished surfaces shall be coated as soon as practicable after being accepted, and before removal from the shop, with a hot mixture of white lead and tallow. Surfaces of iron and steel castings machine-finished for the sole purpose of removing scales, scabs, fins, blisters or other surface deformation shall be given the shop coat of paint.

The composition used for coating machine-finished surfaces shall be mixed in the following proportions: 4 pounds tallow, 2 pounds white lead, and 1 quart linseed oil.

(e) Field Cleaning. When the erection work, including all riveting, straightening of all bent material, etc., is complete, all adhering rust, scale, dirt, grease, unsatisfactory shop paint and other foreign matter shall be removed as specified herein under "Cleaning."

(f) Field Painting. The outside faces of end floorbeams, the bottom of expansion devices, and all parts of steel work inaccessible for painting after erection, are to be thoroughly cleaned of all foreign matter, spot coated and painted their two field coats before erection. This painting shall be done on the site of erection and prior to the placement of the material to allow the paint to become thoroughly dry before assembling. Material so painted shall be placed in a position to require a minimum of handling after being painted, the handling to be done in such a manner as not to damage or abrade the painted surfaces. In case these painted surfaces are damaged during erection, they shall be properly repainted.

After erection and as soon as the field cleaning is done to the satisfaction of the engineer, the spot coat shall be applied to the heads of all field rivets, bolts, pins and nuts, to all abrasions of the shop coat, and to all surfaces on which the shop coat has become damaged. In certain cases where a large portion of shop coat has become defective due to long periods of storage or due to the action of water, mud or other substance, the engineer may require a substantially complete reconditioning or replacement of the shop coat. All such painting shall be considered as spot coat work.

All small cracks and cavities which have not been sealed in a water-tight manner by the first field coat, shall be sealed with red lead paste before second field coat is applied.

To secure a maximum thickness of paint film over rivet heads and edges of plates, angles and other rolled shapes, these parts shall be painted an extra coat in advance of the general application of each field coat.

All metal, after the field cleaning has been completed and the spot coat has dried thoroughly, shall be given two coats of field paint consisting of the first field or primer coat and one coat of aluminum paint as specified in Section 71, "Paints for Wood and Metal," unless otherwise provided in the contract. In no case shall a succeeding coat be applied until the previous coat has dried throughout the full thickness of the paint film. This will require at least 48 hours drying time between successive coats during suitable weather. During unsuitable weather, the interval between successive coats shall be increased at the discretion of the engineer.

45.11. METHODS OF MEASUREMENT. The quantities of the various items which constitute the completed and accepted structure will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing by the engineer.

45.12 BASIS OF PAYMENT. The measured quantities, as provided above, will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, fabricating, welding, erecting, painting, hauling, and placing of all materials and for all labor, tools, equipment and incidentals necessary to complete the work. Such payment shall constitute full payment for the completed structure ready for use. Miscellaneous items not listed in the proposal but shown or billed on the drawings shall be included in the price bid for the other items. No additional allowances will be made for cofferdam construction, falsework, form lumber or other erection expense.

SECTION 46

TIMBER STRUCTURES

46.01 DESCRIPTION. This item shall consist of timber structures constructed in conformity with the plans or as ordered in writing by the engineer, and in accordance with this and other specification items involved.

46.02 MATERIALS. (a) Timber and Lumber. All timber and lumber shall be of the species and grades called for on the plans and as specified under "Treated and Untreated Lumber," Section 54.

(b) Hardware. Bolts, drift pins and dowels may be either wrought iron or medium steel. Washers shall be cast, ogee gray iron castings or malleable castings, unless cut washers are specified on the plans. Ring or shear plate timber connectors shall be of approved design and made of hot rolled low carbon steel A.S.T.M. A17, Type "A" grade.

(1) Bolts. Bolts shall be of the sizes specified and must be perfect in every respect. They shall have square or carriage heads and square nuts, provided however, that large-head type timber bolts of approved design may be used. Screw threads shall make close fits in the nuts. The bolts provided shall be of proper length to project beyond nuts not more than 1/2 inch nor less than 1/4 inch. When bolts are not provided in the proper lengths, the bolts shall be cut off or rethreaded to comply with this requirement. All bolts shall be effectively checked after the nuts are adjusted.

(2) Washers. Washers shall be used between all bolt heads and nuts and the wood, except that carriage bolts, or large-head type timber bolts, shall have washers under nuts only. Cast washers shall have a thickness equal to the diameter of the bolt and a diameter of four times the thickness. For malleable or plate washers, the diameter or side size of the square shall be equal to four times and the thickness equal to one-half the diameter of the bolt. Cast iron washers shall be used when the timber is in contact with earth.

(3) Galvanized Hardware. When galvanized hardware is specified on the plans, all hardware, including nails, spikes, bolts, nuts, washers, uplift straps, drains, sheet iron and all other metal shall be galvanized by the Hot Dip Method and shall have a continuous coating of pure zinc of a uniform thickness so applied that it will adhere firmly to the surfaces, and it shall be capable of withstanding 4 immersions in a standard test solution of copper sulphate without showing any trace of metallic copper on the steel in accordance with the Preece Test. The first 3 immersions shall be for a period of 1 minute each and the 4th immersion for a period of 1/2 minute.

(c) Bridge Iron. Steel truss rods, structural shapes, and plates shall conform to the requirements of the Standard Specifications for Steel for Bridges of the American Society for Testing Materials, serial designation A7. No welds in truss rods will be

permitted. All plates or shapes which are heated to facilitate bending shall be properly annealed. Steel castings shall conform to the requirements of the standard specifications for steel castings of the American Society for Testing Materials, serial designation A27, and shall be Class B medium grade. Iron castings shall conform to the requirements of the standard specifications for gray iron castings of the American Society for Testing Materials, serial designation A48.

46.03 METHOD OF CONSTRUCTION. (a) Handling of Materials. Treated timber shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

(b) Storage of Materials. Timber on the site of the work shall be stored in piles. The ground underneath and adjacent to material piles shall be cleared of weeds and rubbish.

Untreated material shall be close-stacked at least 12 inches above the ground surface and piled to shed water and prevent warping. When requested by the engineer, it shall be protected from the weather by suitable covering.

Treated material shall be close-stacked to prevent warping.

(c) Treatment of Breaks. All places where the surface of treated timber is broken by the cutting, boring, or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar.

(d) Temporary Attachment. Whenever with the approval of the engineer, forms or temporary braces are attached to treated timber with nails or spikes, the holes shall be filled by driving galvanized nails or spikes flush with the surface, or plugging with creosoted plugs after treating with creosote oil.

(e) Bearing. Post and pile caps shall be level and have full even bearing on all posts or piles in the bent and be secured to each pile or post by 3/4 inch diameter drift pin extending at least 9 inches into the pile or post at the approximate center thereof.

(f) Sills and Mud Sills. Timber used for mud sills shall conform to the requirements shown on the plans or in the special provisions. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

Sills shall have true and even bearing on mud sills, piles or pedestals. They shall be drift-bolted to mudsills or piles with bolts of not less than 3/4-inch diameter and extending into mud sills or piles at least 6 inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

(g) Framing. Truss and bent timbers shall be accurately cut, and framed to a close fit in such manner that they will have even

bearing over the entire contact surface of the joint. No blocking or shimming of any kind will be allowed in making joints, nor will open joints be accepted. Mortises shall be true to size for their full depth and tenons shall make snug fit therein.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least 2 nails in each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified on the plans, cross-bridging shall be placed at the center of each span.

Timber to be treated for preservation shall be cut and framed prior to treatment. No unnecessary cutting will be allowed after treatment.

(h) Bolt Holes. Holes for round driftpins and dowels shall be bored with a bit 1/16-inch smaller in diameter than the pin or dowel to be used. The diameters of holes for square driftpins or dowels shall be equal to the least dimension of the pin or dowel. Holes for bolts shall be bored with a bit of the same diameter as that of the bolt. Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread. Holes for rods shall be bored with a bit 1/16 inch greater in diameter than the rod. All holes in treated timber bored after treatment shall be treated with an approved pressure bolt hole treater; holes for rods shall be effectively sealed with hot tar or other suitable waterproofing after insertion of rods.

Countersinking shall be done wherever smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil, and after the bolt or screw is in place, shall be filled with hot tar.

(i) Stringer Sizing. Stringers shall be surfaced one edge or sized at bearings. Outside stringers may have butt joints but interior stringers shall be framed to bear over the full width of floorbeam or cap at each end. The ends shall be securely fastened to the timber on which they rest. When untreated stringers are used they shall be separated at least 1/2 inch for the circulation of air.

(j) Roadway Floors. Roadway floors shall be of the strip or laminated type. Floor plank shall have a nominal thickness of 2 inches and the width shown on the plans and, unless otherwise specified, their length shall be the full width of the roadway. Unless otherwise specified, they shall be sized on one edge to a uniform width and shall not vary in thickness from end to end. Planks shall be laid with the surfaced edge down and each 2-inch piece shall be toe-nailed to each alternate stringer with 20d nails. In addition each piece shall be nailed horizontally to adjacent pieces with 20d nails at 18 inches center to center and staggered both horizontally and vertically with nails in adjacent pieces. All floors shall be cut to a straight line along the sides of the roadway.

(k) Surface Treatment of Deck. After laminated decking is

laid, and curbs, with drains as specified, are completed, the entire top surface of deck and the inside surfaces of curbs, shall be treated with three coats of hot tar conforming to requirements set forth in the American Society for Testing Materials, serial designation D 490-T Grade T-7 or T-8. (T-7 is adapted to cold weather application, T-8 to warm weather application.) This is a tar having a float of 50 to 120 seconds at 32 degrees C.

The tar shall be heated in an open tank or kettle to a temperature between 200 and 225 degrees F. and then applied evenly to the surfaces to be treated at the rate of 1/4 gallon per square yard. Three coats shall be applied at this rate, each coat being given a sufficient time to cool and set up before the application of the succeeding coat is begun.

After the final coat of tar has had sufficient time to cool and set up, and before any vehicles are allowed on the structure, the entire surface of the deck shall be covered with gravel surfacing at the rate of one cubic yard of material per 24 square yards of surface area. The gravel surfacing shall conform to the requirements of any one of the grades of Type A or Type B surfacing given in Section 29, except that crushing will not be required and the amount of material passing the 200-mesh sieve shall not exceed 10 per cent.

The cost of all materials, equipment and labor necessary and incidental to this surface treatment of deck, as well as the materials and labor incidental to the construction of the drain openings in curbs, shall be included in the price bid per thousand feet board measure for treated or untreated lumber in place.

(l) Wheel Guards. Wheel guards shall be constructed as shown on the plans and shall be bolted to the outside stringers by 3/4-inch machine or hook bolts spaced not more than 5 feet center to center. All joints shall be lapped and a bolt shall pass through each lapped joint. When the wheel guard is not blocked up from the floor, drain holes shall be provided at such intervals as to drain the roadway adequately. They shall be provided with galvanized iron lining and arranged so as to discharge free of the structure.

(m) Railing. Railings shall be built as shown on the plans and shall be constructed in a workmanlike and substantial manner. Unless otherwise noted, all railing material shall be untreated and dressed on four sides. All rails shall be squarely butt-jointed at the posts and the rails shall break joints. Nailing of railing will not be permitted.

46.04 PAINTING UNTREATED TIMBERS. The following surfaces shall be thoroughly coated with two coats of hot creosote oil before the timbers are assembled: ends, tops and all contact surfaces of posts sills, caps, floorbeams and stringers; all ends, joints and contact surfaces of bracing and truss members. All surfaces of timber bumpers, the back face of bulkheads and all other untreated timber which is to be in contact with earth shall be similarly treated.

Unless otherwise specified, handrailing and posts shall be painted with three coats of paint conforming to the specifications for

paints for woods as hereinafter set forth in Section 71. All timber to be painted must be seasoned, and painting shall be done only when the timber is free from frost and the surface is perfectly dry and clean. No painting shall be done in damp or freezing weather. All paint shall be thoroughly dry before applying the succeeding coats. It shall be applied in good heavy coats, completely covering every part of the surface and shall be well worked into the joints and open spaces; it shall be so thoroughly and evenly spread that no excessive paint will collect at any point.

46.05 METHOD OF MEASUREMENT. The quantities of timber and other contract pay items in the completed and accepted structure shall be measured for payment in the manner prescribed for the several items involved.

46.06 BASIS OF PAYMENT. The quantities of the several contract pay items as measured above, except truss spans, shall be paid for at the contract unit prices bid for the several items involved, complete in place, according to the plans or as directed in writing by the engineer, which prices shall be full compensation for all material, tools, equipment, labor and all incidentals necessary to complete the structure ready for use.

Timber trusses complete shall be paid for at the price bid per span complete, as shown on the plans which shall include all parts of the bridge except abutments and piers. This price shall be full compensation for all materials, structural steel, steel or iron castings, hardware, equipment, tools, labor, painting, preservative treatment, surface treatment of deck, and all incidentals necessary to complete the structure ready for use.

SECTION 47

BOX CULVERTS AND RETAINING WALLS

47.01 DESCRIPTION. This item shall consist of the furnishing of the necessary materials and the construction of concrete and masonry culverts, culvert pipe headwalls, or retaining walls conforming to the lines, grades and dimensions given, and in accordance with the specifications for concrete and other items which are to constitute the completed structure.

47.02 MATERIALS. All materials used shall be those prescribed for the several items which constitute the structure.

47.03 CONSTRUCTION METHODS. All foundations shall be prepared as specified under Section 14, "Culvert Excavation," and they shall be inspected and approved by the engineer previous to placing any footing.

In general, the base slab or footings of box culverts and retaining walls shall be placed and allowed to set before the walls are constructed. Before concrete is placed in the walls, the footings shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified under "Forming Joints," Section 49.05 (i).

In the construction of box culverts 4 feet or less in height, the sidewalls and top slab may be constructed as monolith. When this method of construction is used, any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

Drains through all walls are to be placed as shown on plans or as directed by the engineer in the field.

47.04 METHOD OF MEASUREMENT. The quantities of the various items which constitute the completed and accepted structures shall be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

47.05 BASIS OF PAYMENT. The measured quantities as provided above shall be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all material, all labor, equipment, tools, drains, and necessary incidentals. Such payment shall constitute full payment for the completed structures ready for use.

SECTION 48

EXCAVATION FOR STRUCTURES

48.01 DESCRIPTION. This item shall consist of all excavation for foundations for bridges, and all other major structures, and shall include the disposal of all material obtained from such excavation and backfilling to the level of the original ground. It shall also include all necessary bailing, drainage, sheeting, and the construction of cribs or cofferdams if found necessary. The excess material shall be disposed of as directed by the engineer and in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

48.02 CLASSIFICATION. All material excavated shall be unclassified and paid for as unclassified excavation for structures, unless otherwise provided in special provisions.

The excavation lines and bases of structures shown on the plans shall be considered as approximate only, and they may be ordered in writing by the engineer to be placed at any elevation, or of any dimensions necessary to give a satisfactory foundation, and no additional compensation will be allowed for any such alteration except as provided under basis of payment.

Boulders, logs, or any unforseen obstacles encountered in excavating shall be removed and no additional compensation will be allowed because of difficulties found in driving through or removing such obstructions.

All timber, sheeting, and other material used in making the excavation shall be removed except as ordered by the engineer, and the cost of performing this work shall be considered as included in the unit price bid for unclassified excavation for structures.

48.03 CONSTRUCTION METHODS. (a) Depth. All foundation excavation shall be carried to a depth satisfactory to the engineer, regardless of the elevations shown on the plans, and unsuitable material shall be replaced with approved material if required. If rock bottom is secured, the excavation shall be done in such a manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the structure, except that for arch substructures, the bottom shall be sloped or stepped as directed by the engineer. All rock or hardpan foundation surfaces shall be freed from loose or disintegrated pieces, thin strata shall be removed, and the surfaces cut to firm bearing and cleaned to the satisfaction of the engineer.

(b) Treatment of Foundation Materials. Where concrete or masonry is to be placed on any excavated surface, special care shall be taken not to disturb the bottom of the excavation more than necessary, and the final removal of the material to grade shall not be made until just before the concrete or masonry is laid. All seams or crevices shall be cleaned out and filled with concrete mortar. When the excavation is at the required depth, water if present shall be pumped out, if possible, for cleaning the foundation bed for inspection. The natural ground adjacent to the structure shall

not be disturbed without permission of the engineer. The existing ground surface at and adjacent to each unit of the substructure shall not be disturbed except as necessary for the sinking of the cofferdams, and all excavation shall be restricted to the area inside of the cofferdams, unless otherwise approved by the engineer.

(c) Cofferdams. Cofferdams or cribs for foundation construction shall, in general, be carried well below the bottom of the footings and shall be well braced and as water-tight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance and this shall be at the sole expense of the contractor. Cofferdams shall be constructed so as to protect green concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure masonry, without written permission of the engineer.

When required by the engineer, the contractor shall submit drawings showing his proposed method of cofferdam construction and other details left open to his choice or not fully shown on the plans. Such drawings shall be approved by the engineer before construction is started, but such approval shall not in any way relieve the contractor of his responsibility to secure a safe and satisfactory cofferdam.

When conditions are encountered which, in the opinion of the engineer, render it impracticable to unwater the foundation before placing masonry, he may require the construction of a concrete foundation seal of such dimensions as may be necessary. The foundation shall be pumped out and the balance of the masonry shall be placed in the dry. When weighted cribs are employed and the weight utilized to partly overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level.

Unless otherwise provided, cofferdams or cribs with all sheeting and bracing shall be removed by the contractor after the completion of the substructure. The removal shall be effected in such a manner as not to disturb or mar the finished masonry.

(d) Pumping. Pumping from the interior of any foundation enclosure shall be done in such manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of concrete, or for a period of at least 24 hours thereafter, unless it be done from a suitable sump separated from the concrete work by a water-tight wall. Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

(e) Inspection. After each excavation is completed, the contractor shall notify the engineer, and no footing shall be placed until after the engineer has approved the depth of the excavation and the character of the foundation material.

(f) Backfilling. All spaces excavated and not occupied by abutments, piers or other permanent work shall be refilled with earth up to the surface of the surrounding ground, with a sufficient allowance for settlement. Where the backfill is to carry the roadway embankment or any part thereof, the backfill shall be made in continuous horizontal layers not greater than 8 inches in thickness, and each layer shall be thoroughly compacted by mechanical or hand tamping before the succeeding layer is placed as specified in Section 15 for approach embankments to bridges and culverts. All other backfill shall be thoroughly compacted and its top surface shall be neatly graded.

All material used for backfill shall be of a quality acceptable to the engineer and shall be free from large or frozen lumps, wood or other extraneous material. In general, this material shall be selected from the material excavated in connection with the substructure involved. Jetting or ponding of the backfill will not be permitted. Water shall be used to expedite settlement of the backfill only when it is difficult to compact the materials, and ordered by the engineer.

The slope bounding the excavation for abutments and wing walls shall be destroyed by stepping or serrating to prevent wedge action.

Adequate provision shall be made for thorough drainage of all backfill by placing coarse gravel or broken stone around drain holes in wing and abutment walls as specified in Section 66 of these specifications or shown on plans.

For foundations through hard material exposed to erosion, the backfill around piers and in front of abutments and wings shall be made of the larger and heavier material selected from material removed from the excavation. If acceptable material is not available in sufficient quantity, the engineer may order said backfill to be made of stone or lean concrete; in which case, unless otherwise provided, this backfill shall be paid for as extra work.

No backfill shall be placed against any masonry abutment, wing wall or culvert until permission shall have been given by the engineer, and preferably not until the masonry has been in place 14 days.

The cost of performing this work shall be considered as included in the unit price bid for unclassified excavation for structures.

(g) Spandrel Fill. The spandrel fill of arch bridges shall be considered a part of the road embankment, shall be composed of earth or gravel, and shall be placed in layers of variable thickness simultaneously over all piers, abutments and arch rings. The lower six inches of material in direct contact with the arch ring waterproofing shall be of fine grading to avoid injury to the waterproof-

ing. At all points the ratio of thickness of each layer to the total depth of the proposed fill shall be approximately constant. The maximum thickness of any layer shall not exceed 18 inches.

This work shall be paid for at the contract unit price bid per cubic yard for unclassified excavation or borrow.

(h) Approach Embankments. When the contract for any bridge structure involves the placement of approach embankments, these shall be constructed and paid for in accordance with the standard specifications governing this class of work.

48.04 METHODS OF MEASUREMENT. The quantity of excavation for which payment will be made will be the volume in place within vertical planes, 18 inches outside of neat lines of footings, from the surface of the ground as it exists at the time when excavation is started, to the elevation shown on the plans, or to such elevation as the engineer may direct, unless otherwise indicated on the plans or in the special provisions.

In case of tie beams, overhangs, or similar construction which extend beyond the footing lines, measurement of excavation shall be limited to 18 inches outside and below neat lines and parallel thereto, provided that the space so measured for payment shall include only that portion not measured for payment under the above paragraph.

48.05 BASIS OF PAYMENT. Payment for all work, prescribed under this item (except spandrel fill and approach embankments), and measured as provided above, shall be made at the contract unit price bid per cubic yard for unclassified excavation for structures, which price and payment shall be full compensation for furnishing all material, for all labor, equipment, tools and incidentals necessary to complete the work.

When it is necessary in the opinion of the engineer, to carry the foundations below the elevations shown on the plans, the excavation for the first 3 feet of additional depth will be included in the quantity for which payment will be made under the item "Excavation for Structures".

Excavation below this additional depth will be paid for on the basis of extra work or at the contract price as the contractor may elect, such choice to be made in writing before work is commenced.

The foregoing provisions shall apply to all and any increased quantities of excavation resulting from the lowering of bridge footings.

SECTION 49

CONCRETE

49.01 DESCRIPTION. This item shall consist of concrete composed of portland cement, fine aggregate, coarse aggregate, and water, prepared and constructed in accordance with these specifications, at the locations and of the form, dimensions, and classes shown in detail on the plans; provided, in addition, that any concrete described on the plans as air-entrained concrete shall meet also the requirements set forth below.

(a) Air-Entrained Concrete. This concrete shall be used in those parts of the structure or structures so indicated on the plans. Air-entrained concrete may be a concrete containing either an air-entraining admixture or an air-entraining portland cement. Unless stipulated in the Special Provisions, either an air-entraining admixture or an air-entraining cement may be used at the option of the Contractor.

(1) Admixtures. In the event an air-entraining admixture is used, the engineer will determine by trial the amount of admixture required to produce concrete having the specified air content and this amount shall not be varied except as directed by the engineer.

(2) Air-Entraining Cement. In the event an air-entraining portland cement is used and it is found impossible to produce concrete having the required air content with the materials and mixing procedure employed by him, the contractor shall make such changes in materials or methods of mixing or both as may be necessary in order to insure full compliance with the requirements of the specifications.

(3) Proportions and Batch Weights. The engineer shall determine the proportions and batch weights for air-entrained concrete in the manner prescribed in 49.03 for regular concrete; provided, however, that in making such adjustments as may be necessary by reason of entrained air, the engineer will use the minimum quantity of fine aggregate and the minimum quantity of water which in his judgment will produce concrete of the required workability.

(4) Entrained Air. Air-entrained concrete, in addition to conforming to the requirements of Section 49.03 for the class or classes specified, shall contain not less than 2 nor more than 5 per cent entrained air, determined by means of the test for air content, A.S.T.M. Designation C138. Tests for entrained air, shall be made by the engineer on concrete containing the materials to be used in the work and employing the type of mixer and mixing procedure which will be used in construction.

49.02 CLASSIFICATION. Concrete will be classified as Class A, Class AD, Class B, Class D, Class DD or Class S. Each class of concrete shall be used in that part of the structure in which it is called for on the plans, or where directed. The following requirements shall govern unless otherwise shown on the plans:

Class A concrete shall be used for reinforced substructures, retaining walls and box culverts.

Class AD concrete shall be used for all superstructures, except where Class D or Class DD is specified on plans.

Class B concrete shall be used for mass footings, pedestals, massive pier shafts and gravity walls, with none or only a small amount of reinforcing.

Class D concrete shall be used for heavily reinforced posts, slabs, beams, girders and curbs having a minimum thickness of 5 inches.

Class DD concrete shall be used for sections less than 5 inches in thickness.

Class S concrete shall be used for all concrete deposited under water.

49.03 COMPOSITION OF CONCRETE AND PROPORTIONING. Concrete shall be proportioned to secure the strength and durability required for the part of the structure in which it is to be used. The concrete of the various classes shall be designed so as to secure concrete having not less than the strengths specified in the following table:

Class	Minimum compressive strength		Maximum size of aggregate	Use
	7 days	28 days		
	Lb.per sq.in.	Lb.per sq.in.		
A	1600	2400	1 1/2	Substructures, retaining walls and box culverts
AD	2000	3000	1 1/2	Superstructures
B	1200	1800	2	Unreinforced sections.
D	2000	3000	1	Heavily reinforced slabs, beams, etc.
DD	2000	3000	3/4	Thin sections.
S	1600	2400	1 1/2	Concrete deposited under water.

Materials shall be proportioned by one of the methods, A, or B, given below. The proportions and batch weights shall be determined after the materials furnished by the contractor have been accepted for the project. Unless otherwise specified in the special provisions, Method A shall be used.

The contractor shall put into each batch the amount of cement and the amount of water and shall weigh into each batch the respective weights of fine and coarse aggregate designated by the engineer for the particular materials being used and the class of concrete being made; except that in batching aggregates for structures containing less than 50 cubic yards of concrete, the contractor may substitute approved volumetric measuring devises in lieu of weighing devices. In such event, weighing will not be required but the volume of coarse aggregate and fine aggregate measured into each batch shall be those designated by the engineer.

(a) Method A. Proportions based on a constant cement factor. The engineer, subject to the requirements of the "Master Proportion Table," shall designate the respective amounts of the job materials to be used in the batch. The sum of the weights of fine and coarse aggregate designated for each class of concrete shall equal the "FIXED" weights shown in the "Total Aggregate" column for the respective types of material. Within the ranges of the table, the engineer shall designate the weight of fine aggregate which, using the materials furnished, will produce a workable mix of the consistency specified, with the least amount of water.

MASTER PROPORTION TABLE

Class	Maximum size of coarse Aggregate Sq.Mesh	Minimum Cement Factor	Weight of fine Aggregate per bag of Cement		Weight of total Aggregate per bag of Cement	Maximum net water content per bag of Cement	Consistency range in slump	
			Min.	Max			Vibrated	Placing Without Vibration
	Inches	Bags (94 lbs per yd.	Lbs.	Lbs.	Lbs.	Gallons	Inches	Inches
			GRAVEL COARSE AGGREGATE					
A	1 1/2	5.5	190	230	595	6.0	1 1/2-3	3 - 4
AD	1 1/2	6.5	135	165	470	6.0	2 - 4	3 - 5
B	2	4.5	220	270	755	7.0	1 - 2	2 - 3
D	1	6.5	135	165	470	6.0	1 1/2-3	3 - 4
DD	3/4	6.5	145	175	470	6.0	2 - 4	3 - 5
S	1 1/2	7.0	120	140	425	6.0	--	4 - 8
			STONE COARSE AGGREGATE					
A	1 1/2	5.5	225	275	595	6.0	1 1/2-3	3 - 4
AD	1 1/2	6.5	170	210	470	6.0	2 - 4	3 - 5
B	2	4.5	275	335	755	7.0	1 - 2	2 - 3
D	1	6.5	170	210	470	6.0	1 1/2-3	3 - 4
DD	3/4	6.5	180	220	470	6.0	2 - 4	3 - 5
S	1 1/2	7.0	155	185	425	6.0	--	4 - 8

Note. Using the maximum allowable water content, the weights given above when multiplied by the corresponding cement factors will furnish a cubic yard of concrete (absolute volume).

The minimum cement factor specified is for usual climatic conditions and quality of concrete materials. Where climatic condi-

tions are favorable, and where concrete materials available produce exceptionally high strength concrete, the engineer may lower the specified cement factor, but not to exceed 10 per cent, with suitable adjustment in water content. When a reduction is made, it shall be stipulated in the special provisions.

The proportions by weight given in the table above are based on the maintenance of an approximately constant quantity of cement per cubic yard of concrete. The proportions are based on the use of aggregates having bulk specific gravities in a saturated surface-dry condition of 2.65 plus or minus 0.05 for sand, gravel and crushed stone. For other specific gravities, the weights shall be corrected by multiplying the weights shown in the table by the ratio of the specific gravities of the aggregates used and those used in computing the table. The bulk specific gravity tests shall be made in accordance with A.A.S.H.O. Method T 84, and Method T 85, (A.S.T.M. Method C 138).

Since the weights given in the table are computed for aggregates in a saturated surface-dry condition, the batch weights shall be corrected to accord with the moisture condition of the aggregates delivered to the measuring bin. Absorption tests shall be made in accordance with the A.A.S.H.O. Method T 84, and Method T 85.

The weights of fine and total aggregate given in the table have been calculated on the basis of using a well-graded natural sand in combination with a well-graded coarse aggregate. These weights are subject to change, depending upon the gradation of the materials furnished by the contractor.

The weights of fine and coarse aggregate will be adjusted by the engineer to insure concrete of satisfactory plasticity and workability, using not more than the maximum permissible net water content shown. During the progress of the work, the total weight of aggregate per bag of cement shall not be changed except under the following conditions:

(1) If concrete of satisfactory plasticity and workability cannot be made without exceeding the maximum net water content, the engineer shall reduce the total weight of aggregate by an amount sufficient to insure that the maximum net water content will not be exceeded, and the contractor shall not receive additional compensation for any extra cement which may be necessary by reason of such adjustment.

(2) If during the progress of the work the specific gravity of one or both of the aggregates changes, the batch weights shall be changed accordingly.

(b) Method B - Proportions based on Strength. The proportions of cement, aggregates and water necessary to conform to these specifications shall be determined by means of preliminary laboratory tests on concrete made with the cement and aggregates which are to be used in the work.

For each class of concrete, the proportions of cement, fine and coarse aggregate, and the quantity of mixing water will be designed by the engineer so as to meet the requirements of the following table:

Class	Maximum Size of Coarse Aggregate	Minimum Compressive Strength		Maximum net water content per bag of cement	Consistency Range in Slump	
					Vibrated	Placing Without Vibration
	Sq.Mesh	7 days	28 days			
	Inches	Lbs.per Sq.in.	Lbs.per Sq.In.	Gallons	Inches	Inches
A	1 1/2	1600	2400	6.0	1 1/2 - 3	3 - 4
AD	1 1/2	2000	3000	6.0	2 - 4	3 - 5
B	2	1200	1800	7.0	1 - 2	2 - 3
D	1	2000	3000	6.0	1 1/2 - 3	3 - 4
DD	3/4	2000	3000	6.0	2 - 4	3 - 5
S	1 1/2	1600	2400	6.0	--	4 - 8

The engineer will furnish prospective bidders, in the special provisions, the proportions by weight and the theoretical cement content per cubic yard which will be required for each combination of materials from regular commercial sources of which previously determined test data are available.

Immediately upon receipt of the award of the contract, the contractor shall furnish the engineer with the exact location of the sources of the materials which he proposes to use. If the source of materials proposed by the contractor is different than set forth in the special provisions, a design of the mix will be made and the proportions officially designated by the engineer. The designated proportions shall be used so long as the materials are actually furnished from the sources originally named and so long as they continue to meet the requirements herein specified, subject only to slight changes in the relative quantities of fine and coarse aggregate for the purpose of promoting workability.

If, during the progress of the work, the contractor wishes to use materials for which no proportions have been designated, the engineer reserves the right to change the proportions in order to meet the requirements specified in the table above using the materials actually furnished.

If, during the progress of the work, it is found impossible to obtain concrete of the required workability with the designated proportions, the engineer may make such changes in proportions as are deemed necessary to secure the desired workability, provided that in no case shall the ratio of water to cement be greater than is specified in the table above for the class of concrete involved, and provided further that any increase or decrease in the amount of cement which may be required as the result of such changes shall be adjusted for or against the contractor, as the case may be, in accordance with the following rule:

If such alterations change the theoretical cement factor originally set forth in the special provisions by 2 per cent or less, no adjustment in the amount paid the contractor will be made. If such alterations change the theoretical cement factor by more than 2 per cent, the source and quality of the aggregates remaining the same, payment will be adjusted for or against the contractor in whatever amount the total cost of cement, f.o.b. contractor's material yard, has been increased or decreased by more than 2 per cent. The amount of such increase or decrease shall be calculated from the theoretical cement factor determined by the laboratory for the material used and not by count of bags of cement used or of the batches where bulk cement is used. No adjustment will be made if the source of materials is different than provided for in the special provisions.

49.04 MATERIALS. (a) Cement and Admixtures. The cement used in the work shall be a portland cement of the type or types shown on the plans; provided, however, that when not so shown, the type or types used shall be type II for regular concrete and type II or IIA, for air-entrained concrete, each type meeting the respective specifications set forth in (1) below. The concrete shall contain no admixture of any kind save as provided under (2) below.

(1) Cement. Portland cement shall conform to the requirements of A.A.S.H.O. Specification M 85, type I, II, III, IV or V as the case may be.

Air-entraining portland cement shall conform to the requirements of A.S.T.M. Designation C 175-T, type IA or IIA.

Low-alkali portland cement shall conform to the requirements of A.A.S.H.O. Specification M 85 for type II with the additional requirement that the total alkali content calculated as the percentage of sodium oxide (Na_2O) plus 0.658 times the percentage of potassium oxide (K_2O) shall not exceed 0.6.

Only one brand of any one type of cement shall be used on the contract except by written permission by the engineer. If more than one brand or grade is permitted by the engineer, each shall be stored separately and shall not be used alternately in any pour. Different shipments of cement shall also be stored separately. The contractor shall provide suitable means for storing cement and protecting it from dampness.

Bags of cement, in which for any reason the cement has become partially set or which contain lumps of caked cement, shall be rejected, provided, however, that the cement from such bags, which is not partially set, caked or otherwise damaged, may be salvaged and used as bulk cement.

(2) Air-entraining Admixtures. The air-entraining agents used shall be stipulated in the special provisions or approved by the engineer. The use of admixtures on which preliminary laboratory and field tests have not been made will not be permitted.

(b) Water. All water used in concrete shall be subject to the approval of the engineer and shall be reasonably clear and free from oil, acid or alkali and vegetable substances, and shall not be brackish or salty. Water of doubtful quality shall be tested in briquettes as prescribed in Tentative Method T 26 of the American Association of State Highway Officials, "Method of Test for Quality of Water to be Used in Concrete," and the strength of such briquettes shall be equal to similar briquettes made of water of known satisfactory quality.

(c) Fine Aggregate. The fine aggregate for concrete shall consist of sand or a combination of sand and stone screenings conforming to the following requirements:

Sand shall consist of clean, hard, durable, uncoated grains, free from lumps, soft or flaky particles, organic matter, loam or other deleterious substances. Sand shall be free from salt and alkali.

Stone screenings shall consist of clean, dustless screenings, resulting from the crushing of tough, durable rock having a per-cent of wear of not more than 35 at 500 revolutions as determined by A.A.S.H.O. Method T 96 (LosAngeles Rattler Test). They shall be free from thin, elongated, or laminated pieces, disintegrated stone, vegetable or other deleterious matter. Screenings shall be free from salt and alkali.

The fine aggregate shall be well graded from fine to coarse and shall meet the following requirements, using A.A.S.H.O. Method T 27:

Passing 4-mesh sieve	95-100%
Passing 10-mesh sieve	60- 90%
Passing 20-mesh sieve	35- 70%
Passing 50-mesh sieve	5- 30%
Passing 100-mesh sieve	0- 10%
Weight removed by elutriation test, not more than	3%

Mortar specimens made with the fine aggregate shall have a compressive strength using A.A.S.H.O. Method T 71, at 28 days, of at least 90 per cent of the strength of similar specimens made with Ottawa sand and having a fineness modulus of 2.40± 0.10.

(d) Coarse Aggregate. The coarse aggregate for all classes of concrete shall consist of broken stone or gravel conforming to the following requirements:

The aggregates shall be free from thin, elongated, laminated or coated particles, organic matter and other deleterious substances.

Coarse aggregate whether produced from rock or gravel shall have a per cent of wear not to exceed 35 at 500 revolutions as determined by A.A.S.H.O. Method T 96 (Los Angeles Rattler Test).

Coarse aggregate shall be well graded, between the limits specified, and the size or sizes designated shall conform to the following requirements when tested by means of laboratory screens:

Designated Sizes	Percentage by Weight Passing Laboratory Sieves having Square Openings							
	2-1/2	2	1-1/2	1	3/4	1/2	3/8	No. 4
No. 4 to 1/2"					100	90-100	40-70	0-15
No. 4 to 3/4"				100	90-100		20-55	0-10
No. 4 to 1"			100	90-100		25- 60		0-10
No. 4 to 1-1/2"		100	95-100		35- 70		10-30	0- 5
No. 4 to 2"	100	95-100		35- 70		10- 30		0- 5
3/4 to 1-1/2"		100	90-100	20- 55	0- 15			
1" to 2"	100	90-100	35- 70	0- 15				

(Attention is called to the fact that the shape of aperture specified for determining compliance with specifications for size of coarse aggregate has no relation to the size or shape of aperature or type of screen used in the production of the material.)

The size of the coarse aggregate for the various classes of concrete with reference to the preceding table of grading requirements shall be as follows:

Class	Designated Sizes
A	No. 4 to 1-1/2 inches
AD	No. 4 to 1-1/2 inches
S	No. 4 to 1-1/2 inches
B	No. 4 to 2 inches
D	No. 4 to 1 inches
DD	No. 4 to 3/4 inches

Rubble one-man stone may be embedded in Class B concrete when shown on the plans, or when the same is a plain mass concrete more than 2 feet in thickness, and permitted by the engineer. These stones shall not be placed within 6 inches of any finished surface of the concrete and shall be placed at least 6 inches apart. The stone for this purpose shall consist of clean, sound, rubble stone, free from structural defects, foreign substances, and coatings of any character, shall be laid on their natural bed, and shall be washed and of a quality satisfactory to the engineer.

(e) Sampling Aggregates. The fine and coarse aggregates shall be sampled in accordance with the method described in Method T 2 of the American Association of State Highway Officials.

(f) Testing Concrete. The concrete for test purposes shall be made with the fine and coarse aggregate and the cement proposed for use on the work, and the concrete shall be mixed to the same consistency as will be used in the construction. Test cylinders shall be made and cured in accordance with A.A.S.H.O. Method T 23. Testing of concrete cylinders shall be in accordance with A.A.S.H.O. Method T 22.

49.05 METHOD OF CONSTRUCTION. (a) Falsework for supporting concrete work shall be built on foundations of sufficient strength to carry the loads without appreciable deformation. Falsework which cannot be founded on solid footings must be supported by ample falsework piling. Falsework shall be designed to carry the full loads coming upon it. All spans shall be given a temporary camber sufficient to allow for shrinkage and settlement. Bridges shall have a permanent camber only when shown on the plans. If appreciable settlement occurs in the falsework, the work shall be stopped, any masonry affected shall be removed and the falsework rebuilt. In general, double wedges or other suitable means shall be provided for constructing and maintaining falsework and forms to correct lines.

If requested by the engineer, detail drawings of the falsework shall be submitted to the engineer for approval, but such approval shall not operate to relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement. Arch centering shall be so constructed as to permit of its being gradually and uniformly lowered or released after pouring the arch ribs or rings.

(b) Forms. Forms shall be so designed and constructed that they may be removed without injuring the concrete.

Forms for exposed surfaces shall be lined with plywood or shall be made of sized and dressed tongue and groove or shiplap lumber, or metal in which all bolt and rivet holes are countersunk so that in either case a plane smooth surface of the desired contour is obtained. Undressed lumber may be used for backing or for surfaces which will not be exposed in the finished structure. All lumber shall be free from knot holes, loose knots, cracks, splits, warps, or other defects affecting the strength or appearance of the finished structure. Form lumber shall be free from bulge or warp, and shall be thoroughly clean if used a second time. Forms for reentrant angles shall be filleted and forms for edges shall be chamfered unless otherwise required by plans or engineer.

In designing forms and centering, the concrete shall be treated as a liquid weighing 150 pounds per cubic foot for vertical loads, and not less than 85 pounds per cubic foot for horizontal pressure. The unsupported length of wooden columns and compression members shall not exceed thirty times the diameter or least side.

The forms shall be so designed that portions where finishing is required may be removed without disturbing portions of forms which are to be removed later, and as far as practicable, so that form marks will conform to the general lines of the structure. Column form marks shall be vertical and symmetrically placed.

When possible forms shall be daylighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit of free access to the forms for the purpose of inspecting, working and spading the concrete.

All forms shall be set and maintained true to line and grade until the concrete is sufficiently hardened. The interior surfaces of forms shall be adequately oiled to insure nonadhesion of mortar. The forms shall be mortartight, and if necessary to close cracks due to shrinkage shall be thoroughly soaked with water. Forms shall remain in place for periods which shall be determined as hereinafter specified. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the engineer shall order the work stopped until the defects have been corrected. Immediately before placing concrete, all extraneous material within the forms shall be removed. For narrow walls and columns, where the bottom of the form is inaccessible, cleanout ports shall be provided at the top surface of concrete where a stoppage of placing occurs. Metal anchorages or tie bolts within the forms shall be so constructed as to permit their removal to a depth of at least 1 inch from the face without injury to the concrete. In case ordinary wire ties are permitted, all wires upon removal of the forms shall be cut back at least 1/4 inch from the face of the concrete. All ties shall be of such design that upon their removal, the cavities which are left will be of the smallest possible size.

(c) Handling, Measuring and Batching Materials. Concrete of the classes indicated shall be made up of acceptable material batched in the proportions set by the engineer for the specific materials. Corrections necessitated by variations in the moisture content of the component materials or for other similar reasons shall be made as directed by the engineer, based upon laboratory determinations.

The coarse and fine aggregate must be handled and measured separately. No batch shall be run requiring fractional bags of cement.

Cement shall be measured by the bag as packed by the manufacturer.

Water shall be measured either by volume or by weight. The allowable error in accuracy of water measuring equipment on the mixer shall not be more than 2 per cent. The equipment should preferably include an auxiliary tank from which the measuring tank shall be filled, and in any case shall be so arranged that the accuracy of measurement will not be affected by variations in pressure in the water supply line.

(d) Equipment for Weighing Aggregates. The weighing methods shall be approved by the engineer prior to the beginning of the batching operations, and the weighing equipment shall conform to the following requirements:

The capacity of the weighing equipment shall be adequate to permit the required weighing of materials without delaying the production of the mixer.

The scales, that is the balance or weighing mechanism, shall be of the beam or springless dial type and shall be the product of an established manufacturer.

Unless the scale is equipped with a multiple weigh beam which permits the weighing of more than one kind of material on the same

scale without changing the settings on the weigh beams, separate scale units shall be furnished for each kind of material to be weighed.

Scales shall be so designed and built that they may be maintained within a maximum tolerance of 1 per cent of the net load being weighed.

The value of the minimum graduation shall not be greater than 2 pounds for scales of 2,000-pound and less capacity, or greater than 5 pounds for scales over 2,000-pound capacity.

Scales of the suspended hopper type shall be equipped with a telltale dial or similar device for indicating to the scale operator that the required load in the weighing container is being approached. Such device shall indicate at least the last 50 pounds of load.

Each scale's installation shall be provided with standard 50-pound test weights which shall be subject to such tests as the engineer deems necessary in order to determine their accuracy. The minimum number of test weights required shall be of a weight equivalent to 10 per cent of the net load capacity of the scales to the nearest greater 50 pounds, but in no case less than two test weights.

(e) Consistency. Concrete shall have a consistency such that it will be workable in the required position. It shall be of such consistency that it will flow around reinforcing steel but individual particles of the coarse aggregate when isolated shall show a coating of mortar containing its proportionate amount of sand. The consistency of concrete shall be gauged by the ability of the equipment to properly place it and not by the difficulty in mixing or transporting. In all cases the amount of water used shall be the minimum necessary to secure the desired workability of the con - crete, within the ranges of slump specified. The quantity of the mixing water shall be determined by the engineer in accordance with 49.03 and shall not be varied without his consent.

(f) Mixing. The concrete shall be mixed only in such quantities as are required for immediate use. No retempering of the concrete will be allowed. Aggregates or bags of cement containing lumps or crusts of hardened material shall not be used.

Concrete shall be thoroughly mixed in a batch mixer of approved type and capacity for a period of not less than one and one-half minutes after all materials, including water, are in the drum.

During such period, the drum shall be operated at drum speeds specified by the mixer manufacturer and shown on his nameplate on the machine. The entire contents of the mixer shall be removed from the drum before materials for the succeeding batch are placed therein and the mixer preferably shall be equipped with mechanical means for preventing the addition of aggregates after mixing has commenced.

The mixer shall be equipped with an approved timing device which will automatically lock the discharging device so as to prevent

the emptying of the mixer until the materials have been mixed the minimum specified time. No mixer shall be operated above its rated capacity and no mixer shall be used which has a rated capacity of less than a one-bag batch.

The first batch of concrete material placed in the mixer shall contain an additional quantity of sand, cement and water sufficient to coat the inside surface of the drum without diminishing the mortar content of the mix. Upon the cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned.

Hand mixing will not be permitted, except in case of emergency and under written permission from the engineer. When permitted, it shall be done only on water-tight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a "crater" and water added in an amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is procured. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least six times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixed batches shall not exceed 1/2 cubic yard in volume. Hand mixing will not be permitted for concrete to be placed under water.

(g) Placing Concrete. Concrete shall then be placed in the forms immediately after mixing and in no case shall concrete be used which does not reach final position in the forms within 30 minutes after water is first added to the mix. The method of placing shall be such as to avoid segregation of the aggregates or displacement of reinforcement.

Use of long chutes for conveying concrete from mixing plant to forms will not be permitted. Troughs, pipes or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete are not separated. Where steep slopes are required the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. When pipes are used they shall be kept full of concrete and have their lower ends kept buried in fresh concrete in the same manner that a tremie is used. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Open troughs and chutes shall be either of metal or metal lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

Dropping the concrete a distance of more than 5 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted.

Placing of concrete shall be so regulated that the pressures caused by the wet concrete shall not exceed those used in the design of the forms.

Special care shall be taken to fill each part of the forms by depositing concrete directly as near final position as possible, to work the coarser aggregates back from the face and to force the concrete under and around the reinforcement bars without displacing them. The placing of concrete shall be done in such manner that the steel reinforcing is not coated with cement before its final embedment. In depositing concrete around steel shapes and closely spaced reinforcing bars the concrete shall be deposited on one side of the steel and worked until it flushes under the steel to the opposite side before any concrete is placed on the opposite side or over the steel. After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

Concrete shall be compacted by continuous working with suitable tools or suitable vibrating equipment in a manner acceptable to the engineer. All concrete, except that placed in handrails or curbs when poured as separate units, or that which is placed under water, shall be compacted by working with an internal vibratory tamper operating with a vibrating frequency of not less than 4,500 per minute, except that on structures involving less than 50 cubic yards, the engineer may, at his discretion, waive this requirement. The vibrating element shall not be attached to, nor shall it be held against, the forms, reinforcing steel, or any other embedded fixtures around which the concrete is being placed. The vibrator shall be so operated that it will not penetrate through the fresh concrete into any that is partially hardened. Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete, along form surfaces and in locations impossible to reach with vibrators.

Concrete shall be placed in each section of the work in a continuous operation working day and night, if necessary, to avoid stoppage planes. It shall be deposited in horizontal layers when practicable, placing thin layers at first that can be thoroughly worked into intimate contact with the concrete beneath. The depth of layers used shall be such that the succeeding layer will be placed before the previous layer has attained initial set. Each layer shall be compacted in a manner that will break up and obliterate any tendency to form a plane of separation between the layers. If it is necessary, by reason of an emergency, to stop placing concrete before any section is completed, bulkheads shall be placed as the engineer may direct. Any place where the placing of concrete is discontinued for a sufficient time to allow the concrete to take initial set shall be deemed a construc-

tion joint and treated as hereinafter described under "Forming Joints," Section 49.05 (1).

Horizontal layers so located as to produce a construction joint at a location wherein a "feather edge" might be produced in the succeeding layer, shall be formed by inset work so that the succeeding layer will end in a body of concrete having a thickness of not less than 6 inches.

In no case shall the work on any section or layer be stopped or temporarily discontinued within 18 inches below the top of any face, unless the details of the work provide for a coping having a thickness of less than 18 inches, in which case, at the option of the engineer, the construction joint may be made at the under side of the coping.

The method and manner of placing concrete shall be so regulated as to place all construction joints across regions of low shearing stress and in such locations as will be hidden from view to the greatest possible extent. The method and sequence of placing concrete for the various types of concrete bridge construction shall be as specified below for the particular type of construction involved.

Concrete in girder haunches less than 3 feet in height shall be placed at the same time as that in the girder stem and the column or abutment tops shall be cut back to form seats for the haunches. Whenever any haunch or fillet has a vertical height of 3 feet or more, the abutment (or columns), the haunch and the girder shall be poured in three successive stages; first, up to the lower edge of the haunch; second, to the lower side of the girder; and third, to completion.

The operation of placing concrete in floor slabs shall be continuous between construction and/or expansion joints. Joints shall be vertical, at right angles to the axis of the roadway, and over the center of a floorbeam or other support provided in the design.

The floors and girders of through girder superstructures shall be placed in one continuous operation unless otherwise specified, in which case special shear anchorage shall be provided to insure monolithic action between girder and floor.

Placing Concrete in Reinforced Concrete Slab and Girder Bridges. Concrete preferably shall be deposited by beginning at the center of the span and working from the center towards the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers.

Concrete in slab spans shall be placed in one continuous operation for each span.

Placing Concrete in Beams. Each beam, between the limits shown on the plans or directed by the engineer, shall be cast in one continuous operation. The top of the concrete shall be kept level and it shall be placed in layers, the thickness of which shall be proportioned to the rate of delivery of the concrete to the forms so that there will be no planes of initial set in any part of the unit. All keyways, seats for secondary beams, dowels and bars that connect the beams with other units of the work shall be in place before the placing of concrete is commenced.

Concrete in T-beam or deck girder spans shall be placed either in one continuous operation or in two separate operations, each of which shall be continuous; first, to the top of the girder stems and, second, to completion. In the latter case, the bond between stem and slab shall be positive and mechanical and shall be secured by means of suitable shear keys with or without dowels in top of girder stem. The size and location of these keys and dowels shall be computed. In general, suitable keys may be formed by the use of timber blocks approximately 2 inches by 4 inches in cross section and having a length 4 inches less than the width of the girder stem. These key blocks shall be spaced along the girder stem as required but the spacing shall be not greater than one foot center to center. The blocks shall be beveled and oiled in such manner as to insure their ready removal.

Placing Concrete in Concrete Viaducts. Concrete in columns shall be placed in one continuous operation, unless otherwise directed. Columns shall be allowed to set at least 12 hours before the caps are placed.

No concrete shall be placed in the superstructure until column forms have been stripped sufficiently to determine character of concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until they have been in place at least 14 days, unless otherwise permitted by the engineer.

Placing Concrete in Concrete Arches. The concrete in arch rings shall be placed in such manner as to load the centering symmetrically. The centering shall be weighted if necessary to prevent distortion.

Arch rings shall be divided into sections of such size that when working simultaneously at points symmetrically located about the crown the sections can be cast in one continuous operation without permitting the formation of planes of initial set. The sections shall be bonded together by suitable keys or dowels. Arch rings may be cast in a single continuous operation when specified on the plans or permitted by the engineer. The arrangement of sections shall be such as to avoid the creation of initial stresses in the reinforcement. Adequate struts shall be provided to resist any unbalanced thrusts to piers in structures composed of more than one span. The size, arrangement, and sequence of placing concrete for sections of all arches shall be subject to the approval of the engineer.

(h) Depositing Concrete Under Water. Concrete shall not be

exposed to the action of water before setting, or deposited in water, except with the approval of the engineer and under his immediate supervision. When concrete is so deposited, the method and manner of placing shall be as hereinafter designated.

All concrete deposited under water shall be mixed in the proportions designated for Class S concrete.

Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie, a closed bottom dump bucket or other approved methods and shall not be disturbed after being deposited. Special care shall be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water and all form work designed to retain concrete under water shall be water-tight. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used it shall consist of a tube having a diameter of not less than 10 inches, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the work and to permit its being rapidly lowered when necessary to choke off or retard the flow. The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow is then stopped by lowering the tremie. The flow shall be continuous and in no case shall be interrupted until the work is completed.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than 1/2 cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

(i) Forming Joints. When the work of placing concrete is delayed until the concrete has taken initial set, the point of stopping shall be deemed a construction joint. The location of construction joints shall be planned in advance and shall be subject to approval by the engineer. The placing of concrete shall be carried continuously from joint to joint. These joints shall then be perpendicular to the principal lines of stress and in general be located at points of minimum shear.

At all horizontal construction joints and at other locations, when directed, a gage strip not less than 2 inches thick shall be placed inside the forms along all exposed faces to give the joints a straight line and eliminate wedge shaped particles of concrete that might chip off. In placing concrete up to construction joints the forms shall be "over filled" at least one inch and all excess material removed.

In joining fresh concrete to concrete that has already set, the forms shall be drawn tight against the face of the set concrete and all gage strips and key forms removed. The surface of the set concrete to be contacted shall then be cut over with suitable tools to remove all laitance, loose and foreign material. This surface shall then be washed and scrubbed with wire brooms, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete, the old surface shall be thoroughly coated with a very thin coating of neat cement mortar.

In order to bond successive courses, suitable keys shall be formed at the top of the upper layer of each day's work and at other levels where work is interrupted. These keys shall be formed by the insertion and subsequent removal of beveled wood strips which shall be thoroughly saturated with water prior to insertion. Rough stone or steel dowels may, at the discretion of the engineer, be used in lieu of keys. All construction joints shall be keyed or doweled as shown on the plans or directed by the engineer.

Sliding joints shall be true planes paralleled to the direction of movement. Where sliding joints are to be provided at the ends of slabs, girders or beams, or between walls, etc., the surface of the supporting concrete shall be given a smooth finish and covered with two layers of three-ply roofing felt to separate the concrete.

Unless otherwise shown on the plans, expansion joints shall be filled with an approved premolded bituminous filler. The thickness of the joints shall be 1/4 inch where the length of the moving concrete is 20 feet or less, 1/2 inch for lengths 21 to 36 feet, and 3/4 inch for lengths of 37 to 50 feet unless otherwise shown on the plans. The joint filler shall be cut to the same shape as the area to be covered but 1/4 inch smaller along all surfaces that will be exposed in the finished work. It shall be firmly fixed against the surface of the concrete already in place in such manner that it will not be displaced when the concrete is deposited against it. Where necessary to use more than one piece to cover any surface, the joint between the separate pieces shall be covered with a layer of two-ply roofing felt, one side of which shall be covered with hot asphalt to insure proper retention. The 1/4-inch space along the edges at exposed faces shall be filled with wooden strips of the same thickness as the joint material. These wooden strips shall be saturated with oil and have sufficient "draft" to make them readily removable after the concrete is placed. Immediately after the forms are removed the expansion joints shall be carefully inspected. Any concrete or mortar that has sealed across the joint shall be neatly cut and removed.

Special water-tight and flashed joints shall be constructed as shown on the plans.

(j) Cold Weather Concreting. During freezing weather provision shall be made for heating the water, aggregates and concrete and the concrete shall be thoroughly protected until set. When concrete operations are carried on during freezing weather the aggregates shall be heated by either steam or dry heat to a tempera-

ture of not less than 70 degrees Fahrenheit and not more than 150 degrees Fahrenheit. The water shall be heated to a temperature between 130 degrees Fahrenheit and 150 degrees Fahrenheit. The temperature of the mixed concrete shall be not less than 65 degrees Fahrenheit and not more than 85 degrees Fahrenheit at the time of placing it in the forms. Neither salt nor chemical admixtures shall be added to the concrete to prevent freezing.

The contractor shall assume all risk in connection with placing concrete in cold weather, and placing the concrete during freezing weather shall in no way relieve the contractor of responsibility for proper results. Should concrete placed under these conditions prove unsatisfactory it shall be removed and replaced at the contractor's expense.

(k) Curing Concrete. (1) Water Curing. Handrails, floors, and troweled surfaces shall be protected from the sun, and in drying weather the whole structure shall be kept wet for a period of 7 days. For concrete requiring finishing, the surface shall be kept moist until finishing is complete. Concrete floor slabs shall be covered with damp sand as soon as the concrete has taken hard set and then kept wet for 7 days. The covering material shall not be cleared from the surface of the floor for a period of 14 days, during which time no traffic shall pass over the structure. Other precautions to insure thorough curing of the concrete shall be taken by the contractor as directed by the engineer.

When directed by the engineer, the contractor shall furnish sufficient canvas and framework, or other type of housing, to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be kept at a temperature not less than 60 degrees Fahrenheit for a period of 7 days after the concrete is placed.

The 7-day curing period is based on the use of a standard Portland cement and a curing temperature of not less than 60 degrees Fahrenheit. If High Early Strength concrete is used, or if the surrounding air temperature during the curing period is less than 60 degrees Fahrenheit, the length of the curing period specified will be altered accordingly by the engineer.

The contractor shall supply such heating apparatus as stoves, salamanders or steam equipment and the necessary fuel. When dry heat is used, means of maintaining atmospheric moisture shall be provided. The heating apparatus shall be such as to heat the mass uniformly and preclude the possibility of the occurrence of hot spots which will burn the material.

(2) Impervious Membrane Method. When provided in the special provisions or upon approval of the engineer, the use of an impervious membrane for curing will be permitted.

The membrane shall consist of a practically colorless impervious liquid which will thoroughly seal the surface of the concrete and will not impart a slippery surface thereto. The quality and quantity to be used shall be approved by the engineer. The liquid shall

contain a coloring matter which does not permanently alter the natural color of the concrete but which will color sufficiently at the time of application to indicate readily the areas covered. The use of any membrane material which would impart a slippery surface to the concrete or alter its natural color will not be permitted. The colorless impervious liquid shall contain not less than 25 per cent solids.

On horizontal surfaces the surface sealing impervious membrane may either be (1) applied three hours after finishing, at which time there should be no visible surface water remaining, or (2) the slab shall be covered by constantly wet burlap for 24 hours before application of the surface sealing impervious membrane.

For other concrete surfaces the impervious membrane may be applied after the forms are removed and the surfaces finished in accordance with the Standard Specifications. If finishing is not required, then the impervious membrane may be applied as soon as the concrete has set sufficiently to permit the removing of forms. All exposed concrete shall be kept damp until the impervious membrane is applied.

The liquid shall be applied under pressure with a spray nozzle at the total rate of not less than 2 gallons per 300 square feet of concrete surface in 2 equal applications and in such manner as to cover the concrete surface with a uniform film which will seal the surface of the concrete thoroughly.

(1) Removal of Forms and Falsework. In order to facilitate finishing, forms on ornamental work, railings, parapets and exposed vertical surfaces shall be removed in not less than 12 or more than 48 hours, depending upon weather conditions. Forms under slabs, beams, girders and arches shall remain in place at least 14 days in warm weather and in cold weather at the discretion of the engineer, except that forms for slabs having a span length of less than 10 feet may be removed at the end of 7 days. Forms shall always be removed from columns before removing shoring from beneath beams and girders in order to determine the conditions of concrete in the columns.

No forms whatever shall be removed at any time without the consent of the engineer. Such consent shall not relieve the contractor of responsibility for the safety of the work. Blocks and bracing shall be removed with the forms and in no case shall any portion of the wood forms be left in the concrete. Lips of mortar and all irregularities caused by form joints shall be removed. The presence of honeycomb areas may be considered sufficient cause for rejection of the structure, and upon written notice from the engineer the contractor shall remove and rebuild the structure in part or in whole as specified, at his own expense.

As soon as the forms are removed, all projecting wires, tie bolts or other metal devices used for holding the forms in place and which pass through the body of the concrete shall be cut back as specified in 49.05 (b), and the holes or depressions thus made, and all other holes, depressions and small voids which show upon

the removal of the forms, shall be repaired as follows: All coarse or broken material shall be chipped away until a dense uniform surface of concrete exposing solid coarse aggregate, is obtained. Feather edges shall be cut away to form faces perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with a thick mortar mixed in the same proportion as that which was used in the body of the work and of the same temperature as the surface against which it is to be placed. The mortar shall be thoroughly tamped into place and the surface floated with a wood float before initial set takes place. The patch shall be kept wet for a period of 5 days, and when finished shall present a neat and workmanlike appearance.

For patching large or deep areas, coarse aggregate shall be added to the patching material and special precautions shall be taken to insure a dense, well bonded and properly cured patch, all as required by the engineer.

Falsework shall not be removed at any time without the consent of the engineer. Such consent shall not relieve the contractor of responsibility for the safety of the work. Falsework shall remain in place after concreting is completed at least 14 days in warm weather and in cold weather at the discretion of the engineer.

Falsework and centering for arches shall not be struck until the fill back of the abutments has been placed up to the spring line. Falsework for rigid frame structures shall not be removed until the fill has been placed back of the vertical legs.

The removal of the falsework will depend upon the results of tests when High Early Strength concrete is used, or when, in the opinion of the engineer, conditions warrant special tests for determining the strength of the concrete.

All falsework piling shall be pulled or cut off one foot below finished ground line where conditions will permit. If conditions are not favorable for pulling or cutting off the piles as stated above, the piles shall be either broken or shot off at the stream bed, unless otherwise provided by the engineer.

(m) Finishing Concrete. All concrete surfaces exposed in the completed work shall comply with the requirements of the clause defining "Ordinary Finish," except as otherwise provided or indicated on the plans.

The concrete bridge seats and tops of piers, walls and curbs shall be brought flush with the finished top surface and struck off with a straight edge and floated. The surfaces, including bottom of overhung or cantilever portions of slabs, outside of exterior beams or girders, faces of abutments or walls and all sides of piers and columns above a point 1 foot below low water line or 1 foot below the finished ground line when such ground line is above the water surface, and all sides of curbs, handrails, arch ribs and struts shall be finished as provided herein for "Rubbed

Finish".

(1) Ordinary Finish. An "Ordinary Finish" is defined as the surface left by the removal of the forms with all holes left by form ties filled and all defects repaired. The surface shall be true and even, free from stone pockets, depressions or projections beyond the surface. All surfaces which can not be repaired to the satisfaction of the engineer shall be given a "Rubbed Finish".

(2) Concrete Floors. Concrete floors shall be struck off with a templet immediately after pouring to provide the proper crown and shall be finished to a smooth even surface by means of both longitudinal and transverse wooden floats, or other suitable means. The finished surface shall not show a variation of over 1/8 inch in 10 feet using a 10-foot straightedge placed parallel to the center line of roadway. When a transversely-broomed finish is used, the allowable variations noted herein shall be independent of the depth of the broom marks. No variations will be permitted that will tend to prevent complete drainage on all parts of the deck. The surface shall be corrected by grinding off the high spots, or other approved method, as may be required in order to conform to these limits. An edging tool shall be used at expansion joints not armoured.

The concrete in bridge seats and tops of walls shall be brought flush with the finished top surface, struck off with a straightedge and floated.

(3) Curbs and Sidewalk Surfaces. Exposed faces of curbs and sidewalks shall be finished to true surfaces having the lines and grades shown on the plans. Concrete shall be worked until the coarse aggregate is forced down into the body of the concrete and a layer of mortar 1/4 inch thick is flushed to the top. The surface shall then be floated to a smooth but not slippery finish. The junction of the sidewalk with masonry parapets shall be finished with a fillet of 3/4-inch radius. Walk surfaces, except sidewalks on bridges, shall be laid out in blocks with a grooving tool as shown on the plans or directed by the engineer. An edging tool shall be used at all edges and expansion joints not armoured.

(4) Rubbed Finish. When the concrete had hardened before being rubbed the surface shall be thoroughly saturated with water and rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the proportions used in the concrete being rubbed. When forms can be removed while the concrete is still green the surface shall be wetted and rubbed with a wooden float. If permitted by the engineer, a thin mortar proportioned as outlined above may be used in the rubbing.

Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface has been obtained. The paste produced by this rubbing shall be kept moist and allowed to set for at least 5 days.

The surface shall then be smoothed by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks.

(5) Special Tooled Finish. Special tooled finish shall be produced with a bushhammer, a pick, a crandall or other tool approved for this purpose. Air tools, preferably, shall be used. No tooling shall be done until the concrete has set for at least 14 days and as much longer as may be necessary to prevent the aggregate particles from being "picked" out of the surface. The finished surface shall show a grouping of broken aggregate particles in a matrix of mortar, each aggregate particle being in slight relief.

(n) Drainage and Weep Holes. Drainage and weep holes shall be constructed in the manner and where indicated on the plans or directed by the engineer. Drains and weep holes in the face of the abutments shall be connected with the roadway drains wherever indicated on the plans. Ports or vents for equalizing hydrostatic pressure shall be placed below low water. Weep holes shall be placed at the elevations shown or directed.

Forms for weep holes through concrete may be clay pipe, concrete drain pipe, or wooden boxes. If wooden forms are used they shall be removed after the concrete is placed. Where weep holes pass through stone masonry the outlet through the masonry shall be rectangular in shape, from 2 to 3 inches in width and from 6 to 8 inches in height. Drain pipes embedded in concrete shall be standard light weight cast iron water pipe or wrought iron pipe.

No direct compensation will be allowed for drainage and weep holes and incidental work in connection therewith. The cost shall be considered as included in the unit prices bid for the various classes of concrete. No deduction will be made in the volume of concrete or masonry for the space occupied by drains and weep holes.

(o) Pipes, Conduits and Ducts. Pipes, conduits and ducts which are to be encased in the concrete, shall be installed by the contractor as the concrete is being placed. They shall be rigidly held against displacement during the placing of the concrete.

No direct compensation will be allowed for furnishing and installing all pipes and conduits shown on the plans. The cost of furnishing, installing and incidental work in connection therewith shall be considered as included in the unit prices bid for the various classes of concrete. No deduction will be made in the volume of concrete for the space occupied by pipes, conduits and ducts.

(p) Defective Work. Any defective work discovered shall be removed immediately and renewed. If the surface of the concrete is bulged, uneven, or shows honeycombing which in the opinion of the engineer cannot be repaired satisfactorily, the entire section shall be removed and renewed. No compensation will be allowed for this work.

49.06 PREFORMED EXPANSION JOINT FILLER FOR CONCRETE. (a) Preformed expansion joint filler shall be of one of the types described below; viz., A, B, C, D, or E; as specified on the plans.

(1) Type A, cork or self-expanding cork. These types shall consist of preformed strips that have been made of clean granulated cork particles securely bound together by an insoluble synthetic resin. The granulated cork shall be relatively free from hard particles or dust and shall not have been exposed in the process of manufacture to a temperature exceeding 300° F. The filler shall meet the test requirements given below under (b) 4, 5, 6, and 7.

(2) Type B, sponge rubber. This type shall consist of preformed strips composed of a durable, elastic rubber compound which may be reinforced on each side with a layer of asphalt treated felt which has been bonded to the rubber compound filler under heat and pressure. The filler shall meet the test requirements given below under (b) 4, 5, and 6.

(3) Type C, cork-rubber. This type shall consist of preformed strips that have been made of clean granulated cork particles securely bound together by a durable, elastic rubber compound. The granulated cork shall be relatively free from hard particles or dust and shall not have been exposed in the process of manufacture to a temperature exceeding 300° F. The filler shall meet the test requirements given below under (b) 4, 5, and 6.

(4) Type D, bituminous (fiber impregnated with bitumen). This type shall consist of preformed strips which have been made of cane or other suitable cellular fibers securely bound together and uniformly impregnated with a suitable asphaltic binder. The filler shall meet the test requirements given below under (b) 1, 4, 5 and 6.

(5) Type E, bituminous (including stiffener and inert filler). This type shall consist of preformed strips of a composition which shall contain asphalt or tar uniformly impregnated with a suitable filler, and may contain thin strips of suitable stiffener. The preformed material shall be of such character that it will not be deformed by ordinary handling during the hot summer months or become hard and brittle in cold weather. The filler shall meet the test requirements given below under (b) 1, 2, 3 and 5.

(b) Test Requirements. When tested in accordance with A.A. S.H.O. Method T 42, premolded expansion joint fillers shall meet such of the following test requirements as are specifically indicated for the particular types to which they belong:

1. Absorption. Type D filler shall not absorb water in greater amount than 15 per cent by volume and type E filler shall not absorb water in greater amount than 5 per cent of its dry weight.

2. Brittleness. Type E filler shall not crack or shatter in the brittleness test.

3. Distortion. Type E filler shall not deflect more than 1 inch in the distortion test.

4. Recovery. Types A, B, and C fillers shall show not less than 90 per cent recovery, and type D filler shall show not less than 70 per cent recovery when tested for recovery.

5. Compression load. The load required to compress types A, B, C, D, and E fillers to 50 per cent of their thickness before the test shall be not less than 100 pounds nor greater than 750 pounds per square inch.

6, Extrusion. Types A, B, C, and D fillers shall not show more than 1/4-inch extrusion when tested for extrusion.

7. Boiling in hydrochloric acid. Types A and B fillers shall show no evidence of disintegration after having been boiled for 1 hour in concentrated hydrochloric acid. Discoloration or a small amount of swelling, shall not be considered as failure.

8. Optional weathering test. At the option of the engineer, types A, B, C, and D fillers shall be subjected to the accelerated weathering test and when so tested shall show no signs of disintegration.

At the option of the engineer, samples that have been subjected to the weathering test shall be tested for recovery, compression and extrusion and samples so tested shall meet the requirements given under 4, 5 and 6 above.

(c) Dimensions. The dimensions of preformed filler shall be as shown on the plans. Tolerances of ± 1/16-inch thickness, ±1/8-inch depth, and ± 1/4-inch length shall be permitted.

(d) Samples. A sample of each thickness of filler shall be submitted from each shipment of 1,000 lineal feet or less and shall consist of a representative section at least 2 feet in length and the full depth of the joint to be filled. Samples shall be packed for transportation in such a manner that there will be no danger of distortion or breakage.

(e) Packing. The self-expanding cork type filler shall be packed at the plant in sizes convenient for handling on the job and shall be wrapped in waterproof paper and sealed in a manner that will prevent entrance of moisture.

49.07 METHOD OF MEASUREMENT. The yardage to be paid for shall be the number of cubic yards of concrete of the several classes, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on plans or ordered in writing by the engineer. The quantity of concrete involved in fillets, scorings and chamfers two square inches or less

in cross-sectional area shall be neglected. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage and weep holes, or pipes, conduits and ducts embedded in concrete. Deduction shall be made for the volume of timber piles, concrete piles, or structural steel, including steel piling but not including expansion joint material, encased in concrete. The volume of timber piles encased in concrete shall be assumed as 0.8 cubic foot per linear foot of pile. No measurements or other allowances will be made for forms, falsework, cofferdams, pumping, bracing, etc.

The yardage shall not include any yardage of concrete contained in any other item when the said other item provides that its pay name be compensation for any concrete involved.

49.08 BASIS OF PAYMENT. The yardage, determined as provided above shall be paid for at the contract unit price bid per cubic yard for "Class A, Class AD, Class B, Class D, Class DD, or Class S Concrete" as the case may be, which price and payment shall be full compensation for the concrete, for all materials, including expansion joint filler, water-stops, weep holes, pipes and conduits indicated on the plans, and for installation of all joints, weep holes, drains, pipes and conduits and for all timber bumpers, forms, falsework, placing and finishing, and for all labor, equipment, tools and incidentals necessary to complete the item, but shall not constitute payment for reinforcing steel, which will be paid for as a separate item.

SECTION 50

REINFORCING STEEL

50.01 DESCRIPTION. This item shall consist of furnishing and placing reinforcing steel or wire fabric of the quality, type and size designated, in conformity with the plans or as ordered in writing by the engineer, and in accordance with this specification. The form of the bars used must be approved by the engineer and shall be such as to provide a net section at all points equivalent to that of a plain square or round bar of equal nominal size. The use of cold twisted bars will not be permitted. Wire fabric shall only be used when specified and shall be of the type shown on plans and approved by the engineer.

50.02 MATERIAL. Reinforcing bars shall meet the requirements of the standard specifications for billet steel concrete reinforcement bars of intermediate grade, serial designation A 15 of the American Society for Testing Materials, unless otherwise specified.

Where purchased from warehouse in small lots, reinforcing may, at the direction of the engineer, be accepted subject to the bending test. Bend test specimens for plain and deformed bars shall be taken from the finished bars, and shall be of the full thickness or diameter of bars as rolled, except that the specimens for deformed bars may be machined for a length of nine inches, if deemed necessary by the manufacturer to obtain uniform cross-sections.

The test specimen shall bend cold around a pin without cracking on the outside of the bent portion as follows:

BEND TEST REQUIREMENTS

Thickness or Diameter of Bars	Type of Bar	
	Plain Bars	Deformed Bars
Under 3/4 in.	180 degrees d = 2t	180 degrees d = 3t
3/4 in. or over	90 degrees d = 2t	90 degrees d = 3t

d = the diameter of pin about which specimen is bent.
t = the thickness or diameter of the specimen.

Wire and wire fabric when used for reinforcement in concrete shall conform to specification A 82 for wire and A 185 for wire fabric of the American Society for Testing Materials. The type of fabric shall be approved by the engineer.

50.03 METHOD OF CONSTRUCTION. When placed, all reinforcement shall be free from dirt, oil, paint, grease, mill scale, loose or thick rust.

When bending is required, it shall be accurately done without the use of heat, and bars having cracks or splits at the bends shall be rejected. All reinforcement shall be placed in the exact position shown on the plans, and shall be so securely held in position

by wiring to and blocking from the forms, and by wiring together at intersections that it will not be displaced during depositing and compacting of concrete. Precast concrete blocks or metal chairs should be used where applicable.

Placing and fastening of reinforcement in each section of the work shall be approved by the engineer before any concrete is deposited in the section.

When bar-bending diagrams are not shown on the contract plans, detail plans showing the bending of reinforcing bars shall be submitted to the engineer for approval.

50.04 SPLICING REINFORCEMENT. Whenever it is necessary to splice reinforcement at points other than those shown on the plans, drawings showing the location of each splice shall be submitted and approved by the engineer before the reinforcing steel is ordered. Splices shall be avoided at points of maximum stress; they shall, where possible, be staggered, and shall be designed to develop the strength of the steel without exceeding the allowable unit bond stress.

50.05 METHOD OF MEASUREMENT. The poundage to be paid for shall be the calculated theoretical weight of the steel as shown on the plans or as ordered in writing by the engineer, complete in place, and accepted. The weights of standard sizes of reinforcing bars shall be computed in accordance with the following tables:

1/4	inch	round	.167	lbs. per foot
3/8	"	"	.376	" " "
1/2	"	"	.668	" " "
1/2	"	square	.850	" " "
5/8	"	round	1.043	" " "
3/4	"	"	1.502	" " "
7/8	"	"	2.044	" " "
1	"	"	2.670	" " "
1	"	square	3.400	" " "
1 1/8	"	"	4.303	" " "
1 1/4	"	"	5.313	" " "

If reinforcing bars, other than standard shapes or wire fabric are required, the unit weight will be shown on the plans.

50.06 BASIS OF PAYMENT. The poundage, determined as provided above shall be paid for at the contract unit price bid for reinforcing steel complete in place, which price shall be full compensation for furnishing the material, all equipment, tools, labor and incidentals necessary to complete the item. No allowance will be made for the clips, wire, separators, or other material used for fastening or supporting the reinforcing steel in place.

SECTION 51

STRUCTURAL STEEL

51.01 DESCRIPTION. This item shall consist of furnishing, fabricating and erecting all structural steel shapes, plates, rivets and all other metal parts not included for payment under some other contract item, all erected in conformity with the plans or as directed in writing by the engineer. Furnishing and fabricating shall include delivery of the shop painted materials to the site of the work as shown on the plans, free of charge. Erecting shall include furnishing and applying field paint, unless otherwise specified.

51.02 MATERIALS. Structural steel, including eyebar, rivet steels, and special alloy steels, shall conform to the requirements of the standard specifications of the American Society for Testing Materials and of the American Association of State Highway Officials, as designated in the following table. Unless otherwise specified on the plans or in the special provisions, structural carbon steel shall be used where structural steel is specified, and structural rivet steel for all rivets.

Type	Designation	
	ASTM	AASHO
Structural carbon and eyebar steel	A-7	M-94
Structural rivet steel	A-141	M-97
High-strength structural rivet steel	A-195	M-98
Structural silicon steel	A-94	M-95
Low-alloy structural steel	A-242	-----
Structural nickel steel	A-8	M-96

Alloy steels shall be plainly marked at frequent intervals for identification. These marks shall be made during or immediately after rolling, shall be of such nature and spacing that they will be visible on practically all pieces during fabrication, and shall be visible after shop and field paints have been applied.

51.03 METHODS OF CONSTRUCTION. All structural steel shall be fabricated, erected and painted as set forth on the plans and as specified in Section 45, "Steel Bridges."

51.04 MILL AND SHOP INSPECTION. (a) Notice of Beginning of Work. The contractor shall give the engineer ample notice of the beginning of work at the mill or in the shop, so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the engineer has been so notified.

(b) Facilities for Inspection. The contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop, and the inspectors shall be allowed free access to the necessary parts of the work.

(c) Inspector's Authority. The inspector shall have the authority to reject any material or work which does not meet the requirements of these specifications. In case of dispute the contractor may appeal to the engineer, whose decision shall be final.

(d) Mill Orders and Shipping Statements. The contractor shall furnish the engineer with as many copies of mill orders and shipping statements as the engineer may direct. The weights of the individual members shall be shown on the statements.

(e) Facilities for Testing. The contractor shall furnish test specimens, as specified herein, without extra charge; also the labor, testing machines and tools necessary to make the specimens and full-size tests.

(f) Rejections. The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the contractor.

51.05 METHOD OF MEASUREMENT. The poundage to be paid for shall be the number of pounds of structural steel of the type or types specified in the fabricated structure including field rivets shipped, but not in excess of the number of field rivets specified in Section 45.05 (17). The weight of erection bolts, field paint, boxes, crates and other containers used for packing and materials used for supporting members during transportation shall not be included.

The weights paid for shall be calculated on the basis of the following assumptions:

(a) The weight of steel shall be assumed at 490 pounds per cubic foot.

(b) The weights of rolled shapes and of plates up to and including 36 inches in width shall be computed on the basis of their nominal weights and dimensions as shown on the approved shop drawings. To the nominal weights of plates more than 36 inches in width, there shall be added one-half of the allowed percentage of overrun in weight given in the Standard Specifications for Steel for Bridges, serial designation A-7, of the American Society for Testing Materials. The weight will be computed on the basis of rectangular dimensions for all plates and overall lengths for all structural shapes and with no deductions for copes, clips, sheared edges, punchings, borings, milling or planing, provided, however, that when parts can be economically cut in multiples from material of larger dimension, the calculated weight shall be taken as that of the material from which the parts can be cut.

(c) The weight of shop rivets shall be based on the weights shown by the following table:

Rivets 1/2" in diameter 20 pounds per 100 rivets.
Rivets 5/8" in diameter 30 pounds per 100 rivets.
Rivets 3/4" in diameter 50 pounds per 100 rivets.
Rivets 7/8" in diameter 100 pounds per 100 rivets.
Rivets 1" in diameter 150 pounds per 100 rivets.
Rivets 1 1/8" in diameter 250 pounds per 100 rivets.
Rivets 1 1/4" in diameter 325 pounds per 100 rivets.

(d) Field rivets and bolts shall be paid for on the basis of their computed weight.

(e) To the total computed weight of metals may be added 0.4 of one per cent as an allowance for shop paint.

(f) Welds shall be paid for on the basis of the computed weight of the metal in the weld.

51.06 BASIS OF PAYMENT. The poundage, determined as provided above, shall be paid for at the contract unit price per pound for Structural steel of the type or types specified, which price and payment shall constitute full compensation for furnishing, fabricating, delivering, erecting ready for use, and painting all the steel and other metal, and for all labor, equipment, tools and incidentals necessary to complete the item.

SECTION 52

BRONZE BEARING PLATES

52.01 DESCRIPTION. Bronze bearing plates, conforming to these specifications, of the sizes and dimensions shown on the plans, shall be furnished and placed as called for on the plans or as directed.

52.02 MATERIAL. Bronze bearing plates shall meet the requirements for bronze bearing metals for turntables and movable railroad bridges, serial designation B-22 (Class B), of the American Society for Testing Materials. Bronze castings shall be free from inclusions of foreign material, casting faults, injurious blowholes or other defects rendering them unsuitable for the service intended.

52.03 METHODS OF CONSTRUCTION. Bearing plates shall be accurately set in correct position as shown on the plans and shall have uniform bearing over the total area. They shall be securely anchored to the concrete with bolts set in the concrete of the size and as shown on the plans. Sliding surfaces shall be planed parallel to the movement of the spans and polished and shall be thoroughly coated with graphite and grease just before being placed in position, and special care shall be taken to avoid placing concrete in such a manner as to interfere with their free action.

52.04 METHOD OF MEASUREMENT. The weight of bronze bearing plates shall be computed from the dimensions as shown on the plans. The weight of bronze shall be assumed to be 536 pounds per cubic foot.

52.05 BASIS OF PAYMENT. Payment will be made at the contract unit price bid per pound for bronze bearing plates complete in plate, which price will be full compensation for furnishing material including bolts, all equipment, tools, labor, and incidentals necessary to complete the item.

SECTION 53

CAST STEEL ROCKERS AND BEARING PLATES

53.01 DESCRIPTION. Cast steel rockers and bearing plates, conforming to these specifications, of the sizes, and dimensions shown on the plans, shall be furnished and placed as called for on the plans or as directed.

53.02 MATERIAL. Steel castings shall conform to the requirements of the standard specifications for steel castings, serial designation A-27, of the American Society for Testing Materials, supplemented by the following: Unless otherwise specified all castings shall be class B, medium grade.

53.03 CONSTRUCTION METHODS. Rockers and bearing plates shall be accurately set and shall have uniform bearing over the total area. For a description of the method to be followed in setting bearing plates see Section 45, "Steel Bridges." Rockers shall not be permanently set until after the bridge floor has been placed and then only after making due allowance for temperature.

53.04 METHOD OF MEASUREMENT. The weight of castings shall be computed from the dimensions shown on the approved shop drawings, with an addition of 10 per cent for fillets and overrun. The weight of cast steel shall be assumed to be 490 pounds per cubic foot.

53.05 BASIS OF PAYMENT. Unless designated as a separate item in the proposal, payment for castings will be made at the unit price bid for structural steel in place. When designated as a separate item in the bid schedule, cast steel will be paid for at the unit price bid complete in place. Price and payment as outlined herein shall constitute full compensation for furnishing materials, and all labor, equipment, tools and incidentals necessary to complete the item.

SECTION 54

TREATED AND UNTREATED TIMBER

54.01 DESCRIPTION. This item shall consist of structural timber of the grades, sizes and dimensions specified, treated or untreated as called for, and furnished in conformity with the plans or as ordered in writing by the engineer, and in accordance with this specification.

54.02 MATERIAL. (a) General. Unless otherwise specified, timber or lumber shall be standard sawn intermountain Douglas fir (Pseudotsuga taxifolia), western larch (Larix occidentalis), Pacific Coast Douglas fir (Pseudotsuga taxifolia), or any equivalent product. All lumber shall be furnished rough unless otherwise specified.

In treated timber trestles all lumber except rails and rail posts shall be Pacific Coast Douglas fir unless otherwise specified.

(b) Grades. Structural timber shall be graded, for the grade selected, in accordance with the grading rules adopted by the regional association of the lumber manufacturers which conform to the basic provisions of the "American Lumber Standards."

Pacific Coast Douglas Fir timber shall be graded in accordance with the "Standard Grading and Dressing Rules" of the West Coast Lumbermen's Association, Book 12, dated March 1, 1943, with subsequent amendments adopted by the Association. The following grades shall be used unless otherwise specified:

Item	Grade	Paragraph No.
Stringers and caps	Select structural beams and stringers, 1600 f.	218
Posts, columns and sills	Select structural posts and timbers, 1200 c.	210
Bulkhead planks, bracing, bridging, handrails and laminated decking	Select merchantable dimension, framing plank, etc.	194
Wheel Guards	Select merchantable timbers, posts and stringers	199
Rail Posts	Select merchantable timbers, posts and stringers.	199

The Western Pine Association's Standard Grading Rules, dated July 1, 1942, with subsequent amendments adopted by the Associa-

tion shall be used for grading timber originating in the intermountain area. Comparable grades to those specified herein for West Coast Lumbermen's Association rules shall be used when grading under the Western Pine Association's rules.

Only pieces consisting of sound wood, free from any form of decay, are acceptable, unless otherwise specified.

When untreated timber is specified, it shall show not less than 85 per cent heartwood on the girth, measured at the point where the least amount of heartwood occurs on any girth.

When treated timber is specified, there will be no heartwood requirements and the amount of sapwood will not be limited.

(c) Incising. All Douglas fir lumber treated with creosote or creosote petroleum mixture, whose least dimension is 3 inches or over, shall be incised in a suitable power driven machine. Lumber having a thickness of 4 inches and over shall be incised on all four sides. Lumber less than 4 inches thick shall be incised on the wide faces only, unless otherwise indicated on the drawings. The spacing and shape of the cutting teeth and the method of incising shall be such as to produce a uniform penetration. The depth of the incisions shall be not less than the followings

Size	Minimum depth of incision
3 x 12	7/16"
4 x 12	1/2"
8 x 10	9/16"
10 x 12	5/8"
12 x 12	3/4"

Intermediate sizes in proportion

54.03 INSPECTION. Each shipment of lumber to be treated shall be inspected at the treating plant both before and after treatment by an inspector designated by the engineer. The inspector shall stamp the ends of each accepted piece with a suitable stamp which has been copyrighted by him, of which a true impression has been filed with the Montana Highway Commission. The inspector shall also file with the Montana Highway Commission an itemized report of all timber inspected, giving temperatures, amount of preservative, time of treatment, lengths and sizes of timbers, total footage, and

other pertinent information. Treated timber which does not bear in legible form the stamp of the inspector shall not be shipped from the treating plant.

Each shipment of untreated lumber shall be inspected at its source by an inspector designated by the engineer insofar as is economically practical. In cases where the engineer deems inspection impractical the material may be covered by a "Certificate of Inspection" from the Pacific Lumber Inspection Bureau, the West Coast Lumbermen's Association or the Western Pine Association, as designated.

The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the contractor.

54.04 TREATED TIMBER. Treated timber shall be interpreted to mean timber treated by a pressure method to retain at least the minimum quantity per cubic foot of the preservative treatment stipulated in the table below. All treated timber in trestles shall be treated with creosote oil or creosote coal tar solution unless otherwise specified.

CREOSOTE OR CREOSOTE COAL TAR SOLUTION

Material	Minimum net retention of preservative per cubic foot of wood.
Structural Timber - 5 inches or less in thickness	10 lbs. empty cell
Structural Timber - more than 5 inches in thickness	8 lbs. empty cell
Timber piles	8 lbs. empty cell

Salts Treatment	Pounds Dry Salt per Cubic Foot
Zinc Chloride	1.00
Sodium floride-arsenate-dinitrophenol solution (Wolman Salts)	0.35
Chromated zinc chloride	0.75
Zinc Meta-arsenite (ZMA)	0.35

54.05 TIMBER PRESERVATIVES. These specifications cover the type and quality of materials used in the preservative treatment of timber. The materials include the following:

Creosote oil
Creosote-coal-tar solution
Creosote-petroleum solution
Zinc chloride
Sodium fluoride-arsenate-dinitrophenol (Wolman Salts)
Chromated Zinc chloride
Zinc meta arsenite (ZMA)

(a) Creosote oil and creosote-coal-tar solution. (1) Creosote shall be distillate of coal-gas tar or coke oven tar. The creosote-coal-tar solution shall be a coal-tar product of which at least 80 per cent shall be a distillate of coal-gas tar or coke-oven tar and the remainder shall be refined or filtered coal-gas tar or coke-oven tar.

(2) Creosote oil and creosote-coal-tar solution shall conform to the following requirements:

	Creosote Oil	Creosote coal-tar Solution
Water content, max. per cent	3.0	3.0
Matter insoluble in benzol, max. per cent (Note)	0.5	2.0
Specific gravity 38/15.5 C., Minimum	1.03	1.05
Maximum	----	1.12
Distillate, water free basis		
Up to 210 C., max. per cent	5.0	5.0
Up to 235 C., max. per cent	25.0	25.0
Coke residue of oil, max. per cent	2.0	6.0

NOTE: Samples of creosote or creosote-coal-tar solution taken from working tanks may show an increase in matter soluble in benzol due to treating operations. Such increases, provided they do not exceed by 1 per cent of the specification limits, should not serve to cause rejection of the creosote for non-conformity with specifications if it can be shown that the original fresh oil was of specified quality.

(b) Creosote-Petroleum Solution. Creosote-petroleum solution shall meet the following requirements:

(1) It shall contain not less than 50 per cent by volume of coal-tar creosote as specified in Section (a) (2).

(2) The petroleum shall have the following properties.

Specific gravity, 60/60 F., min. 0.96
NOTE: The specific gravity shall not exceed 15.9° as determined by the standards of the American Petroleum Institute.
Water and sediment (B.S. + W.), max. per cent 1.0
Flash point, min., F. 215
Viscosity at 210 F., sec. 40-60
NOTE: Petroleum of higher viscosity may be used if the penetration requirements of specifications covering treatment details are met.

(c) Zinc Chloride. Zinc chloride shall be acid-free and shall not contain more than 0.1 per cent of iron. Fused or solid zinc chloride shall contain at least 94 per cent chloride of zinc. Concentrated zinc chloride shall contain at least 50 per cent chloride of zinc.

(d) Sodium Fluoride-Arsenate Dinitrophenol Solution (Wolman Salts). (1) The preservative composed of sodium fluoride-arsenate dinitrophenol and neutralizing chromates in the dry form shall have the following composition:

	Per Cent by Weight	
	Normal	Minimum (Moisture-free Basis)
Sodium Fluoride	25	22
Disodium hydrogen arsenate	25	22
Sodium Chromate	37 1/2	34
Dinitrophenol	12 1/2	5
Total of above	---	95

(2) The sodium fluoride content shall be determined as described in Scott (Scott's "Standard Methods of Chemical Analysis", 5th edition, Vol. 1), pages 407-408, by the thorium nitrate volumetric method applied to the distillate from a Willard Winter Distillation process.

(3) The disodium hydrogen arsenate content shall be determined with standard iodine after reduction to the arsenious state, as described in Scott (Scott's "Standard Methods of Chemical Analysis", 5th edition, Vol. 1), page 99.

(4) The sodium chromate content shall be determined by titration with potassium permanganate after reduction of the chromate with ferrous salt solution, as described in Scott, pages 288-289.

(5) Organic substances shall be removed prior to the chromate and arsenate determinations, as described in Scott, page 91.

(6) Dinitrophenol shall be determined by extraction with carbon tetrachloride and bromination, as described in Sutton (Sutton's "Systematic Handbook of Volumetric Analysis", 12th edition), page 415.

(e) Chromated Zinc Chloride. Chromated zinc chloride in the dry form shall have the following properties:

(1) It shall contain not less than 77.5 per cent of zinc chloride calculated from the total soluble zinc content. The material shall be tested in accordance with standard methods 1b and 27a of the American Wood Preservers' Association.

(2) It shall contain hexavalent chromium equivalent to not less than 17.5 per cent sodium dichromate dihydrate ($Na_2CR_2O7-2H_2O$). This may include chromium trioxide sufficient to produce in a 3 per

cent solution of chromated zinc chloride a pH no lower than 3.0. The material shall be tested in accordance with standard method 1b of the American Wood Preservers' Association.

(3) Chromated zinc chloride in concentrated solution or fresh working solution shall contain zinc chloride and sodium dichromate calculated as dihydrate in the proportions stated in Paragraphs 1 and 2, when calculated to the dry basis.

(4) Samples of chromated zinc chloride treating solutions taken from working tanks or treating cylinders may show a change in composition due to treating operations. Such changes shall not serve to cause rejection of the preservative if they do not raise the ratio of zinc chloride to sodium dichromate dihydrate to more than 8 to 1, and if it can be shown that the original fresh preservative was of specified composition.

(f) Zinc Meta-Arsenite (ZMA) (1) Zinc Meta-arsenite shall be prepared at the treating plant from the separate ingredients under proper technical supervision.

(2) The materials shall be mixed in approximately the following proportions:

Arsenious acid (As_2O_3) - - - - - 120 lbs.
Zinc oxide (ZnO) - - - - - 80 lbs.
Acetic acid -- sufficient to keep the zinc meta-arsenite in solution under operating conditions.

(3) The impurities in the treating solution shall not be of such character or quantity as to interfere with maintaining the desired proportions of As_2O_3 and ZnO or with the deposition of zinc meta arsenite in the wood.

(4) The net retention of preservative shall be calculated as the pounds of dry As_2O_3 plus ZnO deposited in the wood in the proportion of five parts of the former to two parts of the latter. An excess of either ingredient above this proportion shall not be counted in the net retention.

(g) Methods of Sampling and Testing. In addition to the methods given above, sampling and testing of wood preservatives shall be in accordance with the following standard methods of the American Association of State Highway Officials and the American Society for Testing Materials:

	A.A.S.H.O	A.S.T.M.
Sampling and testing creosote	T-60	D-38
Specific gravity of creosote	T-82	D-368
Specific gravity of creosote fractions	T-74	D-369
Water in creosote	T-83	D-370
Insoluble matter in creosote	T-81	D-367
Distillation of creosote	T-62	D-246
Coke residue of creosote	T-61	D-168
Specific gravity of petroleum	----	D-287
Water and sediment in petroleum	----	D-96

	A.A.S.H.O.	A.S.T.M.
Flash point	T-73	D-93
Viscosity	T-72	D-88
Analysis of zinc chloride	----	D-199

54.06 METHOD OF MEASUREMENT. Unless otherwise provided, treated timber and untreated timber complete in place according to the plans and these specifications will be measured separately by the thousand feet board measure. Measurements will be computed from the dimensions shown on the plans, unless changes in such dimensions have been authorized by the engineer. Standard timber sizes and lengths will be used in computations. This measurement will include only such timber as is a part of the completed and accepted work, and will not include timber used for erection purposes, such as falsework, forms, bracing, sheeting, etc.

54.07 BASIS OF PAYMENT. The quantities, determined as provided above, shall be paid for at the contract unit prices per thousand feet board measure, (M.b.m.) for "Untreated Timber" or "Treated Timber" as the case may be, which prices and payments shall constitute full compensation for procuring, furnishing, and delivering all lumber and timber, for any preservative treatment required, for all hardware, and all other metal parts used in the item, for preparing, framing, assembling, erecting, and painting, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Timber bumpers at the end of concrete floor slabs shall be considered an incidental part of the work paid for under concrete.

Timber trusses shall be paid for at the price bid per span complete, as specified in Section 46.06.

SECTION 55

PILING

55.01 DESCRIPTION. This item shall consist of furnishing and placing piling in conformity with the plans and these specifications or as ordered in writing by the engineer. Foundation, trestle and sheet piles shall be untreated timber, treated timber, concrete or structural steel, all as shown on the plans and called for in the bid schedule. No alternate types or kinds of piling, save such as are shown on the plans or as called for in these specifications, shall be used.

55.02 REQUIREMENTS FOR ALL PILING. Piling shall be designed to sustain the total pressure which may be transmitted to the foundation. Piles shall be spaced not closer than 2 feet 6 inches center to center unless they rest on a hard stratum and act as columns. The distance from the side of any pile to the nearest edge of the footing shall not be less than 9 inches. In general, piles shall be used only in places where a minimum penetration of 10 feet in firm material, or 20 feet in soft material, can be obtained. For foundations of arch, continuous span, or movable bridges, or high abutments the piles shall be completely embedded in firm earth, sand, or gravel which will afford good lateral support. When this result is impracticable, the soft material shall be excavated from the pit and replaced by heavy riprap, for such distance and depth as the plans indicate or the engineer directs.

In general, all excavations of the foundation in which piles are to be driven shall be complete before driving is commenced. After driving is completed, all loose and displaced materials shall be removed from around the piles, leaving a clean, solid surface to receive the concrete.

When subject to transverse forces, batter piles shall be driven in sufficient numbers to resist the transverse forces without assistance from the vertical piles.

The contractor shall be responsible for determining the length of all piles except timber trestle piles. Piles for timber trestles shall be of the lengths shown on the plans and called for in the bid schedule, unless otherwise ordered in writing by the engineer.

The work shall be subject at all times to inspection by the engineer. The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the contractor.

55.03 TIMBER PILING. (a) Description. Timber piles shall consist of round or square timber of the kind and dimensions specified, driven in the location and to the elevations shown on the plans or as directed by the engineer, and in conformity with these specifications.

(b) General. Timber piles which will be below water level at all times, may be of any species of wood which will satisfactorily withstand driving.

In piling for use in exposed work, the diameter of the heartwood shall be not less than 8/10 of the required diameter of the pile.

Treated piles shall be treated with the creosote oil or creosote coal tar solution described in the specifications for treated timber.

The ranges of pressure, temperature, and time duration of treatment shall be controlled so as to result in maximum penetration of the quantity of preservative injected, which shall permeate all of the sapwood and as much of the heartwood as practicable.

For general construction, treated piles shall be treated in such manner as to retain not less than 8 pounds of the preservative per cubic foot by any standard empty cell process.

(c) Quality. All wood piling shall be cut from solid, sound, live trees, preferably during the winter season. The piling shall show on the butt end not less than six annual rings in the fourth inch, measured on any radial line and beginning at a point 3 inches from the center of the heart pith; shall be free from injurious ring shakes, rot, loose or unsound knots; and shall withstand the specified driving without splitting or excessive brooming of heads. Sound knots will be permitted provided the diameter of the knot does not exceed 4 inches or 1/3 the diameter of the stick at the point where it occurs. Any defect or combination of defects which will impair the strength or durability of the pile more than the maximum allowable knot shall not be permitted. Piles shall be cut above the ground swell and shall have a uniform taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not lie farther from the center of the pile at any point than 1 per cent of the length of the pile. Piles with short or reverse bends or kinks shall not be accepted. Piles with spiral grain which makes one complete turn in 50 feet or less shall not be accepted.

Unless otherwise specified, all piles shall be peeled by removing all of the rough bark and at least 80 per cent of the inner bark. No strip of bark remaining on the stick shall be over 3/4 inch wide or over 8 inches long, and there shall be at least 1 inch of clean wood surface between any two such strips. Not less than 80 per cent of the surface on any circumference shall be clean wood. All knots shall be trimmed close to the body of the pile. The butts shall be sawed square and the tips shall be sawed square or tapered to a point not less than 4 inches in diameter, as directed by the engineer.

(d) Inspection. Untreated timber piles shall be inspected at the site of the work by the engineer.

Treated timber piles shall be inspected at the creosoting plant before treatment for grade and suitability by an inspector designated by the engineer. The inspector shall stamp each pile on the butt end with a stamp which will make an impression that is readily legible after treatment. The stamp shall be copyrighted by the inspector and a true impression filed with the Montana Highway Commission. After treatment the piles shall again be inspected by the inspector, who shall stamp each pile on the butt end with a stamp differing from that used before treatment, and of which a true impression has also been filed with the Montana Highway Commission. The inspector shall file with the Montana Highway Commission an itemized report of all piles inspected, giving temperatures, amount of preservative, time of treatment, lengths and sizes, total footage, and any other pertinent information. Treated timber piles which do not bear in legible form the stamps of the inspector made both before and after treatment shall not be shipped from the creosoting plant.

(e) Dimensions. Round piles shall have a minimum diameter at the tip, measured under the bark, as follows:

Length of Pile	Tip Diameter
Less than 40 feet	8 inches
40 to 60 feet	7 inches
Over 60 feet	6 inches

The minimum diameter of piles at a section 3 feet from the butt, measured under the bark, shall be as follows:

	Diameter	
Length of Pile	Douglas Fir Southern Yellow Pine Southern Cypress	All Other Species
20 feet and under	11 inches	11 inches
21 to 30 feet	12 inches	12 inches
31 to 40 feet	12 inches	13 inches
Over 40 feet	13 inches	14 inches

The diameter of the piles at the butt shall not exceed 20 inches. Square piles shall have the dimensions shown on the plans.

(f) Methods of Construction. The tops of all piles shall be sawed to a true plane as shown on the plans, and at the elevation fixed by the engineer. Piles which support timber caps or grillage shall be sawed to conform to the plane of the bottom of the superimposed structure. In general, the length of pile above the elevation of cut-off shall be sufficient to permit the complete removal of all material injured by driving, but piling driven to very nearly the cut-off elevation shall be carefully freed of all splintered or otherwise injured material.

In timber trestle construction, the piles for any one bent shall be carefully selected as to size to avoid undue bending or

distortion of sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents for any given structure.

Collars or bands to protect timber piles against splitting and brooming shall be provided where necessary.

Timber piles shall be pointed where soil conditions require it. When necessary, the piles shall be shod with metal shoes as shown on the plans or of a design satisfactory to the engineer, the points of the piles being carefully shaped to secure an even and uniform bearing on the shoes.

55.04 CONCRETE PILING. (a) Description. Concrete piles shall be made in accordance with these specifications and the designs shown on the plans. They shall be placed in accordance with these specifications in the location and to the elevation shown on the plans or as directed by the engineer.

(b) Material. All concrete materials and their preparation and placing shall be in accordance with the requirements for Class D concrete.

Reinforcement shall conform to the requirements for reinforcing steel of these specifications, and the weight and dimensions shall be as shown on plans.

Where waterproofing is to be used, special specifications will be given and the work shall be in accordance therewith.

The average diameter shall not be less than 12 inches, and the diameter at the point not less than 8 inches. The length shall not exceed 30 times the average diameter for piles driven through firm soil and shall not exceed 15 times the average diameter for piles driven to rock through loose, wet soil or filled ground. When lateral support is deficient, so that the piles act as columns, they shall be designed as columns.

(c) Method of Construction. Precast piles shall be made in accordance with the plans, and reinforcement shall be accurately placed and rigidly secured in such manner as to insure its proper location in the completed pile. Special reinforcement at the top and bottom to protect them from damage in driving shall be provided. The centers of the main reinforcing bars shall be not closer to the surface of the concrete than 2 1/2 inches. The concrete shall be carefully placed, tamped, and spaded, care being taken to fill every part of the form and to work the concrete around and under the reinforcement without displacing it. The piles shall be cast separately, or, if alternate piles are cast in a tier, the intermediate piles shall not be poured until four days after pouring the adjacent piles. Piles cast in tiers shall be separated by tar paper carefully placed. The concrete shall be placed continuously in each pile. The completed piles must be free from stone pockets, porous spots, or other defects,

and be straight and true to the form specified. The forms shall be true to line, built of surfaced lumber and a 1-inch chamfer strip shall be used in all right-angle corners; they shall be water-tight and shall not be removed within 24 hours after the concrete is placed. All exposed surfaces of the pile shall be given a rubbed finish. The piles shall be cured at least 40 days at a temperature of not less than 40 degrees F., or 28 days at a temperature of not less than 60 degrees F., except that if high-early-strength cement is used the curing time may be reduced to 7 days, under temperature not less than 60 degrees F. Piles shall not be driven until this curing time is completed. When concrete piles are lifted or moved they shall be supported at the quarter points and they shall be so designed that the unit stresses produced by handling, as described above, will not exceed 650 pounds per square inch compression in concrete nor 12,000 pounds per square inch tension in steel.

(d) Piles Cast in Place. When piles are cast in strong metal shells which have been driven in accordance with the specifications for driving concrete piles and which remain in place after the concrete has set, the safe loads for piles completely embedded in firm earth may be taken the same as for precast piles of the same size or diameter. No pile of this type shall be concreted until all driving within a radius of 6 feet has been completed, and care shall be taken that the piles are in no way disturbed until the concrete has become hard.

55.05 STRUCTURAL STEEL PILES. Structural steel piles shall be rolled steel sections of the weight and shape called for on the plans. They shall be structural steel meeting the requirements for "Steel for Bridges" A.S.T.M. designation A 7. Piles bent or otherwise injured will be rejected.

55.06 DRIVING. (a) Untreated Timber. Timber piles shall be driven with a gravity hammer, steam hammer, or a combination of water jets and hammer.

Gravity hammers for driving timber piles shall weigh not less than 2,400 pounds and the fall shall be so regulated as to avoid injury to the piles and in no case shall exceed 20 feet. Steam hammers when used shall develop a total energy of not less than 6000 foot-pounds per blow.

Pile driver leads shall be constructed in such a manner as to afford freedom of movement to the hammer and they shall be held in position by guys or stiff braces to insure support to the pile during driving. Except where piles are driven through water, the leads preferably shall be of sufficient length so that the use of a follower will not be necessary.

Water jets may be used in combination with a hammer. The volume and pressure of the water at the jet nozzle, and the number of jets used, shall be sufficient to freely erode the material adjacent to the pile. If water jets and a hammer are used for driving, the jets shall be withdrawn and the piles shall be driven by the hammer to secure the final penetration. This procedure may be var-

ied if the desired results are not obtained.

Piles shall be driven strictly in accordance with the lines and spacing shown on the plans, and not more than 1/4 inch variation per foot from the vertical or from the batter line will be allowed. Unless otherwise ordered in writing by the engineer, timber piling shall be driven to a minimum bearing value of 20 tons, but in no case less than the design loads shown on the plans. In the absence of loading tests, the safe bearing values shall be determined by the following formulae:

For single acting steam hammers . . . . $P = \frac{2WH}{S+0.1}$

For double acting steam hammers . . . . $P = \frac{2H\ (W+Ap)}{S+0.1}$

For gravity hammers . . . . $P = \frac{2WH}{S+1.0}$

Where P = safe load per pile in pounds,
W = weight in pounds of striking part of hammer,
H = height of fall in feet,
A = area of piston in square inches,
p = steam pressure in pounds per sq. inch at hammer,
S = the average penetration in inches per blow for the last 10 to 20 blows for steam hammers, or of 5 to 10 blows for gravity hammers.

These formulas are applicable only when
(a) The hammer has a free fall.
(b) The penetration is at a reasonably quick and uniform rate.
(c) There is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.
(d) The head of the pile is not broomed or crushed.
(e) A follower is not used.

(b) Treated Timber. Driving of treated timber piling shall be identical with that prescribed for untreated timber piling, with the following additional requirements applying to treated timber piling:

Treated piles and timbers shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. They shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

All places where the surface of treated piles or timbers is broken by cutting, boring, or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar. Hot creosote oil shall be poured into the bolt holes before the inser-

tion of the bolts in such manner that the entire surface of the holes shall receive a coating of the oil.

(c) Concrete Piles. Requirements for driving large concrete piles will be covered by special provisions. Under usual conditions, that is, piles containing not over 2 cubic yards of concrete, they shall be driven with steam hammers developing not less than 12,000 foot pounds per blow at each full stroke of the piston, or with drop hammers weighing not less than the pile, with a maximum drop of 8 feet. In driving, the tops of the piles shall be protected by suitable cushions of wood, rope or other material, so placed as to reduce the injury to the pile to a minimum. Metal shoes or points of an approved design shall be used when ordered by the engineer. Concrete piles shall be driven in accordance with the requirements of Section 55.06 (a) to sustain safely the design loads shown on the plans.

(d) Structural Steel Piles. Steel piles shall be driven in accordance with the requirements of Section 55.06 (a) to sustain safely the design loads shown on the plans. The heads shall be cut squarely and an approved cast or structural steel driving cap shall be provided to hold the axis of the pile in line with the axis of the hammer and to prevent deformation of flange or web.

(e) Treatment of Timber Pile Heads after Cut-off. After the necessary cutting has been done to receive the cap, the heads of all timber piles shall be given three coats of hot creosote oil. They shall then be covered with a coat of hot tar, over which will be placed a sheet of 22-gauge galvanized iron, or a covering may be built up of alternate layers of hot tar and loose-woven fabric similar to membrane waterproofing, using four layers of tar and three of fabric. The cover shall measure at least 6 inches more in each dimension than the diameter of the pile and shall be bent down over the pile and the edges fastened with large-headed nails or secured by binding with galvanized wire. After the cover is in place, the cap shall be placed and drift-pinned as specified in Section 46, "Timber Structures."

(f) Modification of Spacing. In case the above carrying capacity can not be obtained, plans showing the necessary modification of the design of the footings and the number and location of the piles required shall be furnished by the engineer.

55.07 SPLICING OF PILES. Full length piles shall always be used where practicable but if splices can not be avoided splicing shall be done according to methods shown on the plans or as directed by the engineer. When the splicing of steel piles or steel shells of special piles is done by welding the arc method shall be given preference.

Extensions, splices or build-ups on concrete piles, when necessary, shall be made as follows: After the driving is completed, the concrete at the end of the pile shall be cut away, leaving the reinforcing steel exposed for a length of 40 diameters. The final cut of the concrete shall be perpendicular to the axes of the pile.

Reinforcement similar to that used in the pile shall be securely fastened to the projecting steel and the necessary form work shall be placed, care being taken to prevent leakage along the pile. Just prior to placing concrete the top of the pile shall be thoroughly wetted and covered with a thin coating of neat cement, retempered mortar or other suitable bonding material. The forms shall remain in place not less than 7 days and then shall be carefully removed and the entire exposed surface of the pile finished as above specified.

55.08 LOADING TESTS. If specified on the plans or in the special provisions, or if for any reason the engineer deems it advisable to make load tests on one or more piles, the contractor shall load the test piles with a test load equivalent to twice the bearing value to which the piling is to be driven as shown on the plans or specified. The loading platform shall be so constructed that the readings may be taken directly on the pile. Care shall be exercised in cutting off and capping the piling to insure an even bearing surface in a horizontal plane over the entire end of the piling. The loading platform shall be so constructed and the loading material shall be of such a character as to permit the load being evenly balanced and distributed over the bearing area of the piling.

In lieu of a loading platform, hydraulic jacks with suitable yokes and pressure gages may be used.

The pile shall first be loaded with 25 per cent of the test load, this load being allowed to remain undisturbed for a period of 6 hours. The loading shall then be increased to 50 per cent of the test load, after which a period of rest of 12 hours shall be allowed before further loading. The remainder of the test load shall be applied half at a time with a period of 6 hours between loadings. The entire test shall be allowed to remain in place for a period of 48 hours, after which the test load shall be removed and the platform dismantled.

The permanent settlement shall not exceed 1/4 inch in 48 hours unless otherwise specified. If the permanent settlement exceeds 1/4 inch in 48 hours, the engineer may order the load reduced until the maximum load is determined which will not cause a settlement in excess of the allowable. In case the safe carrying capacity of any pile is found by test or by formula if not tested, to be less than the load that it was intended to carry, additional piles shall be driven until the load per pile to be borne is reduced to safe carrying capacity.

55.09 TEST PILES. For his information the contractor may drive such test piles as he may believe necessary, provided, however, that the number of test piles to be paid for as such shall not exceed the number of test piles authorized on the plans or ordered in writing by the engineer.

In all cases he shall furnish the piles and necessary equipment. The location and manner of driving of test piles shall be

at the discretion of the contractor, save that the contractor shall cooperate with the engineer in facilitating the keeping of accurate records of driving and complete field data and, after he has finished with any individual test pile, shall drive such test pile to any deeper penetration that the engineer may order, and save that when so indicated on the plans, the location and manner of driving of test piles shall be as ordered by the engineer. Unless otherwise indicated on the plans, the test piles furnished shall be of sufficient length to permit driving to practical refusal and shall be of the same section and size required for piles in the structure.

55.10 METHOD OF MEASUREMENT. Untreated timber, treated timber, and concrete piles shall be paid for on the basis of the lineal feet of piling left in place in the completed and accepted structure, or at a unit price per pile, as called for in the bid schedule.

Quantities used in payment for structural steel piles shall include the materials and work specified under "Steel Bearing Piles" and "Driving Steel Bearing Piles" as follows:

> Steel Bearing Piles. The quantity to be paid for shall be the number of pounds of structural steel in the steel bearing piles, and in the materials used in capping or splicing where same is specified, computed from the nominal weights of the specified sections. To this computed weight shall be added the weights of all welds incidental to the placing of caps or splicing where same are specified.
>
> Driving Steel Bearing Piles. The quantity to be paid for under this item shall be computed on the basis of the lineal feet of piling driven below the bottoms of the substructure units.

Test piles, whether or not utilized as service piles in the structure, shall not be included in the above.

The number of test piles to be paid for shall be the number of test piles driven as ordered, provided however, that the number shall not exceed the number of test piles authorized on the plans or ordered in writing by the engineer.

The number of loading tests to be paid for shall be the number of loading tests made, completed and accepted.

The number of pile shoes to be paid for shall be the number of shoes of approved design ordered and used on accepted piles.

55.11 BASIS OF PAYMENT. Untreated timber piling, treated timber piling and concrete piling shall be paid for at the unit price bid per pile, or at the unit price bid per lineal foot determined as provided above, as called for in the bid schedule, complete in place; which prices and payment shall constitute full compensa-

tion for all materials, labor, equipment, tools and incidentals necessary to complete the items.

Steel bearing piles shall be paid for at the unit price bid per pound for the quantity as determined above; which price and payment shall constitute full compensation for all materials delivered at the site and shall include all costs necessary and incidental to the cutting off of piles if required, and to the capping of same, where specified on the design plans.

Driving steel bearing piles shall be paid for at the unit price bid per lineal foot for the footage as determined above, which prices and payment shall constitute full compensation for all materials, labor, equipment, tools and incidentals necessary to complete the item.

Test piles determined as provided above, shall be paid for at the price bid, which price and payment shall constitute full compensation for all materials, labor, equipment, tools and incidentals necessary to complete the item.

The number of loading test of piles determined as provided above shall be paid for at the contract unit price each for "Loading Test of Piles," which price and payment shall constitute full compensation for building the loading platform, procuring and placing the loading material, and removing and disposing of the platform and material, or for furnishing necessary equipment for other approved methods of testing, for making the test and for removing the equipment.

The number of pile shoes, determined as provided above, shall be paid for at the contract unit price each for "Pile Shoes", which price and payment shall constitute full compensation both for furnishing the shoes and for utilizing the same on piles as ordered.

DIVISION II

CONSTRUCTION DETAILS

PART IV – INCIDENTAL CONSTRUCTION

DIVISION II

CONSTRUCTION DETAILS

PART IV, INCIDENTAL CONSTRUCTION

SECTION 56

REINFORCED CONCRETE PIPE

56.01 DESCRIPTION. This item shall consist of reinforced concrete pipe conforming to these specifications, of the sizes and dimensions shown on the plans, furnished and placed as directed.

Reinforced concrete pipe to be used for the construction of culverts shall be of two classes known respectively as "Standard Reinforced Concrete Pipe" and "Extra Strength Reinforced Concrete Pipe." Extra strength pipe shall be used under all embankments which are more than 20 feet in height. In case the class of pipe is not indicated on the plans or in the proposals, it shall be understood that the pipe called for is to be "Standard Reinforced Concrete Pipe." Where so indicated on the plans or proposal form, or in the special provisions, flared end terminal sections of pipe shall be used. These sections may, at the option of the contractor, be precast flared end sections as shown on standard sheet C7 or they may be cast in place in conformity to the design shown on standard sheet C7-1.

TABLE 1.—DESIGN AND STRENGTH TEST REQUIREMENTS OF STANDARD-STRENGTH REINFORCED CONCRETE CULVERT PIPE.

Internal Diameter of Pipe, in.	Concrete, 3500 psi.			Concrete, 4500 psi.			Strength Test Requirements, lbs. per linear ft. of pipe	
	Minimum Shell Thickness, in.	Minimum Reinforcement,* sq. in. per linear ft. of pipe barrel		Minimum Shell Thickness, in.	Minimum Reinforcement,* Sq. in. per linear ft. of pipe barrel		Three-Edge-Bearing Method**	
		Circular Reinforcement in Circular Pipe	Elliptical Reinforcement in Circular Pipe and Circular Reinforcement in Elliptical Pipe		Circular Reinforcement in Circular Pipe	Elliptical Reinforcement in Circular Pipe and Circular Reinforcement in Elliptical Pipe	Load to Produce 0.01-Inch Crack	Ultimate Load
12	2	1 line 0.07	.....	1 3/4	1 line 0.08	.....	2250	3500
15	2 1/4	1 line 0.09	.....	2	1 line 0.11	.....	2625	4065
18	2 1/2	1 line 0.12	1 line 0.10	2	1 line 0.14	.....	3000	4500
24	3	1 line 0.17	1 line 0.13	2 1/2	1 line 0.20	1 line 0.17	3000	5000
30	3 1/2	1 line 0.22	1 line 0.17	3	1 line 0.28	1 line 0.21	3375	5750
36	4	2 lines, each 0.18	1 line 0.18	3 3/8	2 lines, each 0.22	1 line 0.22	4050	6600
42	4 1/2	2 lines, each 0.21	1 line 0.21	3 3/4	2 lines, each 0.25	1 line 0.25	4725	7350
48	5	2 lines, each 0.25	1 line 0.25	4 1/4	2 lines, each 0.31	1 line 0.31	5400	8000
54	5 1/2	2 lines, each 0.30	1 line 0.30	4 5/8	2 lines, each 0.37	1 line 0.37	5850	9000
60	6	2 lines, each 0.33	1 line 0.33	5	2 lines, each 0.41	1 line 0.41	6000	10000
66	6 1/2	2 lines, each 0.37	1 line 0.37	5 1/2	2 lines, each 0.45	1 line 0.45	6300	11000
72	7	2 lines, each 0.40	1 line 0.40	6	2 lines, each 0.48	1 line 0.48	6600	12000
78	7 1/2	2 lines, each 0.43	1 line 0.43	6 1/2	2 lines, each 0.51	1 line 0.51	....	.....
84	8	2 lines, each 0.46	1 line 0.46	7	2 lines, each 0.54	1 line 0.54	....	.....
90	8	2 lines, each 0.56	1 line 0.56	....	.....	.....	....	.....
96	8 1/2	2 lines, each 0.60	1 line 0.60	....	.....	.....	....	.....
102	8 1/2	2 lines, each 0.72	1 line 0.72	....	.....	.....	....	.....
108	9	2 lines, each 0.78	1 line 0.78	....	.....	.....	....	.....

*The distance from the center line of the reinforcement to the nearest surface of the concrete has been assumed in the design tables as 1 1/4 in. for pipe with a shell 2 1/2 in. or more in thickness.

** Test loads for sand-bearing tests shall be one and one-half times those specified in this table for the three-edge-bearing tests.

TABLE II.--DESIGN AND STRENGTH TESTS REQUIREMENTS OF EXTRA-STRENGTH REINFORCED CONCRETE CULVERT PIPE

Internal Diameter of Pipe, in.	CONCRETE, 4500 psi.			Strength Test Requirements, lbs. per linear ft. of pipe	
	Minimum Shell Thickness, in.	Minimum Reinforcement, + sq. in. per linear ft. of pipe barrel		Three-Edge-Bearing Method ++	
		Circular Reinforcement in Circular Pipe	Elliptical Reinforcement in Circular Pipe and Circular Reinforcement in Elliptical Pipe	Load to Produce a 0.01-in. Crack	Ultimate Load
24....	3	1 line 0.26	1 line 0.20	4 000	6 000
30....	3 1/2	1 line 0.31	1 line 0.24	5 000	7 500
36....	4	2 lines, each 0.28	1 line 0.28	6 000	9 000
42....	4 1/2	2 lines, each 0.33	1 line 0.33	7 000	10 500
48....	5	2 lines, each 0.38	1 line 0.38	8 000	12 000
54....	5 1/2	2 lines, each 0.44	1 line 0.44	9 000	13 500
60....	6	2 lines, each 0.50	1 line 0.50	9 000	15 000
66....	6 1/2	2 lines, each 0.56	1 line 0.56	9 500	16 500
72....	7	2 lines, each 0.60	1 line 0.60	9 900	18 000
78....	7 1/2	2 lines, each 0.65	1 line 0.65	---	---
84....	8	2 lines, each 0.72	1 line 0.72	---	---
90....	8	2 lines, each 0.84	1 line 0.84	---	---
96....	8 1/2	2 lines, each 0.90	1 line 0.90	---	---
102....	8 1/2	2 lines, each 1.08	1 line 1.08	---	---
108....	9	2 lines, each 1.17	1 line 1.17	---	---

+The distance from the center line of the reinforcement to the nearest surface of the concrete has been assumed in the design tables as 1-1/4 in. for pipe with a shell 2-1/2 in. or more in thickness.

++ Test loads for sand-bearing tests shall be one and one-half times those specified in this table for the three-edge-bearing tests.

56.03 MANUFACTURE. Concrete pipe furnished under these specifications shall be produced by a plant for which the method of manufacture and quality of product have been approved by the Commission prior to the date of award of contract.

The equipment and methods for controlling the proportions for the concrete, the forming and placing of reinforcement, the consolidation of the concrete in the molds, the protection and curing of the pipe, the molds, headers and pallets, shall be inspected and approved by the engineer prior to beginning fabrication.

The shell thickness and the amount of circumferential reinforcement shall not be less than that given in the design tables for the classes and sizes of pipe and the strength of concrete therein specified.

The distance from the center of the reinforcement to the nearest or tension surface of the concrete shall not be less than 3/4 inch for pipe 12 inches in diameter, or less than 1 inch for pipe more than 12 inches in diameter.

Pipe of the internal diameters listed in the design tables shall be considered standard sizes for culvert construction. In elliptical pipe, the inside diameter at the minor axis shall be equal to the diameter of the corresponding size of circular pipe.

The ends of the pipe shall be of such design that the pipe when laid shall make a continuous conduit with a smooth and uniform interior surface.

In circular pipe having one line of circular reinforcement, the reinforcement in the barrel of the pipe shall be placed equally distant from the inner and outer surfaces of the pipe. In circular pipe having two lines of circular reinforcement, each line shall be so placed that the net protective covering of concrete over the reinforcement in the barrel of the pipe shall be not less than 1 inch. In circular pipe having elliptical reinforcement, and in elliptical pipe having circular reinforcement, the reinforcement in the barrel of the pipe shall be so placed that the net protective covering of concrete along the vertical diameter of the pipe shall be not less than 1 inch from the inside surface of the pipe, and the net protective covering of concrete along the horizontal diameter of the pipe shall be not less than 1 inch from the outside surface of the pipe.

Each line of circumferential reinforcement shall be assembled into a cage and have sufficient longitudinal bars or members, extending through the barrel of the pipe, to afford rigidity and maintain the reinforcement in exact shape and correct position within the form.

The reinforcement shall be lapped not less than 30 diameters or, if welded, the joints shall develop the full strength of the reinforcement. The spacing center to center of adjacent rings of circumferential reinforcement in a cage shall not exceed 4 inches

up to and including pipe 48 inches in diameter, nor exceed the shell thickness for larger pipe and shall in no case exceed 6 inches.

The bell shall have a circumferential reinforcement equal in unit area to that of a single line within the barrel of the pipe.

In tongue-and-groove pipe 36 inches in diameter and larger there shall be a line of circumferential reinforcement in the groove equal in area to that of a single line within the barrel of the pipe.

56.04 WORKMANSHIP AND FINISH. Pipe shall be substantially free from fractures, large or deep cracks and surface roughness. The planes of the ends of the pipe shall be perpendicular to their longitudinal axes.

Variations of the internal diameter shall not exceed 1 1/2 per cent nor shall the shell thickness be less than that intended in the design by more than 5 per cent at any point.

Variation of the position of the reinforcement shall not exceed 1/4 inch from the position provided in the design for pipe having an internal diameter of 48 inches or less, and shall not exceed 1/2 inch for larger pipe; but the cover on reinforcement shall not be less than 3/4 inch at any point.

56.05 MARKING. The following shall be clearly stenciled on the pipes:

(a) The pipe class (by an "S-C" for Standard Pipe, and an "X-C" for Extra Strength Pipe.)

(b) The date of manufacture.

(c) The name or trademark of manufacturer, and

(d) Elliptical pipe with circular reinforcing and circular pipe with elliptical reinforcing shall have the word "Top" or "Bottom" clearly stenciled on the inside of the pipe at the correct place to indicate the proper position when laid.

56.06 PHYSICAL TESTS. The State shall be entitled to test a number of pipe not exceeding 2 per cent of the total amount required for the project and such pipe shall be furnished without cost to the State. All pipe for testing purposes shall be selected at random by the engineer from the stock of the manufacturer and shall be pipe which would not otherwise be rejected under these specifications. The pipe shall be free from visible moisture when tested.

By agreement between the engineer and the manufacturer the continued acceptability of the pipe, after the preliminary pipe tests have been made, may be determined by tests of the quality of the concrete as placed in the pipe and examination of the quality, amount and accuracy of placement of the reinforcement. The quality of the concrete shall be determined on 6-inch diameter by

12-inch test cylinders taken from the concrete used in making the pipe and manufactured and cured under identical conditions with the pipe. When tested in accordance with standard methods these cylinders shall be a strength of not less than the ultimate strength that was assumed in the design of the pipe.

Pipe shall be acceptable under the strength tests when all test specimens meet the test requirements. Should less than three of ten preliminary test specimens fail to meet the test requirements, then the manufacturer will be allowed a retest on two like specimens for each specimen that failed, and the pipe shall be acceptable only when all of these retest specimens meet the test requirements. No further retests shall be permitted.

The absorption shall not exceed 8 per cent for test specimens taken from pipe designed to be made of concrete having a compressive strength of 3,000 or more pounds per square inch. Pipe shall be considered to meet these specifications, for absorption, when not less than 80 per cent of the number of specimens tested, including any retested, meet the test requirements. When the initial absorption specimen from a pipe fails to meet these specifications, the absorption test shall be made on another specimen from the same pipe and the results of the retest shall be submitted for the original test results.

Pipe will be considered ready for shipment when they meet the test requirements, or when tests of 6-inch diameter by 12-inch cylinders show that the concrete has attained the ultimate strength assumed in the design of the pipe.

Every manufacturer furnishing pipe under these specifications shall furnish all facilities necessary to carry out the tests herein provided.

56.07 INSPECTION. All material, processes of manufacture, and finished pipe shall be subject to inspection and approval by the engineer. The manufacturer when so directed by the engineer shall have holes cut in such sections of the finished pipe (not exceeding one hole in every 50 sections delivered) as desired so that a proper inspection may be made of the quantity and placement of the reinforcement. If the pipes are tested for strength or absorption, inspection of the reinforcement shall be made on the pipe used for those tests, and in no case shall the total number of pipe cut open for inspection of reinforcement exceed the number to which the State is entitled under the provisions of Section 56.06.

Pipe shall be subject to rejection on account of failure to meet any of the specification requirements or on account of the following:

(1) Fractures or cracks passing through the shell, except that at an end crack that does not exceed the depth of the joint, or a fracture that at its deepest point does not exceed the depth of the joint nor extend more than 10 per cent around the circumference shall not be considered cause for rejection unless these defects exist in more than 5 per cent of the pipe inspected.

(2) Defects which indicate imperfect mixing and moulding.

(3) Hand patching of pipe after being removed from moulds.

(4) Evidence that reinforcing material is too close to surface of pipe.

All rejected pipe shall be plainly marked by the inspector and shall be replaced by the manufacturer with pipe which meets the requirements of these specifications.

56.08 CONSTRUCTION METHODS. A trench shall be excavated to the depth and grade established by the engineer, due allowance being made for necessary camber. The width of the trench shall not be greater than necessary to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe, unless otherwise authorized due to unsuitable material encountered. The bottom of the trench shall be shaped to conform to the bottom of the pipe for at least 10 per cent of its outside diameter and afford a uniform, firm and true bed throughout its length, free from projecting stones, roots or other inequalities in the bedding surface. In the case of bell and spigot pipe, recesses shall be excavated to receive the bells. Where rock or hardpan is encountered, the trench shall be excavated to a depth at least 6 inches below the grade established for the bottom of the pipe. This excess depth shall be refilled with earth backfill and thoroughly compacted. All soft, unsound material underlying the proposed pipe shall be removed to the depth required by the engineer and shall be replaced with approved pit run gravel or coarse aggregate in layers not exceeding 4 inches in depth and each layer shall be thoroughly compacted by tamping.

The pipe shall be laid with the bell or groove end upgrade and all joints shall be caulked and filled with mortar composed of 1 part of cement and 2 parts of fine aggregate. Before succeeding sections of pipe are laid, the lower portion of the hub of the preceding pipe shall be plastered on the inside with mortar of sufficient thickness to bring the inner surface of abutting pipes even. After the pipe is laid the remainder of the joint shall be filled with mortar, and sufficient additional mortar shall be used to form a bead with a minimum thickness of one-half the shell thickness of the pipe, around the joint. The inside of the joint shall be wiped clean and finished smooth. Joints shall be thoroughly wetted before the mortar is placed. After initial set, the cement mortar on the outside shall be protected with an earth covering.

After the bedding has been prepared and the pipe installed, selected embankment material, free from large or frozen lumps, clods, or rocks, shall be placed alongside the pipe in layers not exceeding 6 inches in depth and shall be thoroughly compacted so that on each side of the pipe there shall be a berm of thoroughly compacted or undisturbed earth at least as wide as the external diameter of the pipe. Each layer shall be then compacted by rolling or by tamping, with mechanical rammers or by hand-

tamping with heavy iron tampers having a tamping face not exceeding 25 square inches in area, special care being taken to thoroughly compact the fill under the haunches of the pipe. This method of filling and compacting shall be continued until the embankment is 8 inches above the top of the pipe. When the construction calls for placing high embankments over the culverts, special instructions shall be given by the engineer.

56.09 METHOD OF MEASUREMENT. Reinforced concrete pipe culverts shall be measured by the lineal foot of pipe complete in place, including flared-end terminal sections if called for by the plans.

56.10 BASIS OF PAYMENT. This item shall be paid for at the contract unit price per foot bid for the different diameters of pipe, which price and payment shall be full compensation for furnishing, hauling, and installing the pipe including flared-end terminal sections, if required, and for all materials, equipment, tools, labor and incidentals necessary to complete the item, but shall not constitute payment for excavation or headwalls.

SECTION 57

GALVANIZED CORRUGATED METAL PIPE CULVERTS

57.01 DESCRIPTION. This item shall consist of corrugated metal culvert pipe, conforming to these specifications, of the sizes and dimensions shown on the plans, furnished and placed as directed.

57.02 MATERIAL. Corrugated metal culvert pipe shall be fabricated from corrugated sheets, the base metal of which shall be made by the open hearth process. The base metal in the finished sheets shall conform to the following chemical requirements:

Elements	Chemical Composition by Ladle Analysis. Position of Base Metal Does not Indicate Preference					Tolerance by Check Analysis of Finished Sheets
	Pure Iron	Copper Bearing Pure Iron	Copper Iron	Copper Molybdenum Iron	Copper Steel	
Carbon						
Maximum per cent	---	---	---	---	---	---
Manganese						
Maximum per cent	---	---	---	---	---	---
Phosphorous						
Maximum per cent	.015	.015	.015	.015	---	---
Sulphur						
Maximum per cent	.040	.040	.040	.040	.050	.010
Silicon						
Maximum per cent	---	---	---	---	---	---
Copper						
Minimum per cent	---	.20	.20	.40	.20	.02
Molybdenum						
Minimum per cent	---	---	---	.05	---	---
Sum of First Five Elements						
Maximum per cent	---	.10	.25	.25	.70	.04
Sum of First Six Elements						
Maximum per cent	.10	---	---	---	---	.04

(a) Rivets. All rivets shall be of the same material as the base metal specified for the corrugated sheets. They shall be thoroughly galvanized or sherardized.

(b) Gauge Determination and Tolerance. The gauge of culvert sheets shall be determined by weight only. The gauge weight tolerances shall be those given in Table III of the Standard Specifications for Zinc-coated (Galvanized) Sheets, Serial Designation A 93, of the American Society for Testing Materials and subsequent revisions. The portion of this table which applies to the sheets provided for in this specification is as follows:

Galvanized Sheet	Theoretical weight of galvanized sheet [2]	Permissible tolerances in weights of sheets, plus or minus, in percentage of theoretical weight.[1]		
		All of one gauge and size in shipment.	Single Packages	Single Sheets
Gauge	Oz.per sq.ft.	Per cent	Per cent	Per cent
8	112.5	5	7	10
10	92.5	5	7	10
12	72.5	5	7	10
14	52.5	5	7	10
16	42.5	5	7	10

[1]References are to gross weights of bundled material and to net weights of crated and boxed material. If the minimum or maximum only be ordered, double tolerance is to be taken on permissible side.

[2]All of one gauge and size in shipment shall apply to lots of not less than 6,000 pounds.

(c) Spelter Coating. The base metal sheets shall be uniformly galvanized on both sides by the hot process. A uniform coating of Prime Western Spelter shall be applied at the rate of not less than 2 ounces per square foot of metal. If the average spelter coating as determined from samples shows less than 2 ounces of spelter per square foot of metal, or if any one sample shows less than 1.8 ounces of spelter per square foot of metal, the shipment shall be rejected. Sheets having blister spots, holes or other imperfections in the galvanizing after corrugating shall be rejected.

The tests for weight of spelter coating shall be made as described in the Tentative Method T 65 of the American Association of State Highway Officials.

(d) Accepted Brands. No metal will be accepted under these specifications and no bids will be considered for the materials above described until after the sheet manufacturer's certified analysis and manufacturer's guarantee have been passed upon by the engineer and accepted.

Misbranding or other misrepresentation and non-uniformity of product will each be considered a sufficient reason to discontinue the acceptance of any brand under these specifications, and the notice of discontinuance of any brand sent to the sheet manufacturer will be considered to be notice to any culvert companies which handle that particular brand.

(e) Certified Analysis. The manufacturer of each brand shall file with the engineer a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the percentage of each of the seven above mentioned chemical elements. The cer-

tificate shall be sworn to for the manufacturing company by a person having legal authority to bind the company.

(f) Manufacturer's Guarantee. The manufacturer of the sheets shall submit with the certified analysis a guarantee providing that all metal furnished shall conform to the certified analysis filed, shall bear a suitable identification brand or mark, and shall be replaced without cost to the purchaser when not in conformity with the specified analysis, gauge or spelter coating; and the guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material.

(g) Identification. No culverts will be accepted unless the metal is identified by a stamp on each section showing: First, name of sheet manufacturer; second, name of brand; third, the gauge.

The identification brands shall be placed on the sheets by the manufacturers of the sheets, in such a way that when rolled into culverts such identification shall appear on the outside of each section of each pipe. Pipe having any sections not so stamped shall be promptly rejected.

(h) Tests. Laboratory tests shall follow the tentative method of sampling and testing as adopted by the American Association of State Highway Officials. The analysis made by the chemists or inspection bureau designated or approved by the engineer shall be taken as final, but before any considerable shipment is rejected a check analysis shall be made.

If the engineer so elects, he may have the material inspected at the rolling mill or the culverts inspected at the shop where they are fabricated. He may require a chemical analysis from the mill for any heat, also a physical test of the properties of the metal taken from any heat, to be made by the mill. The inspection both at the mill and at the shop shall be made under the direction of the engineer. The engineer, or his representative, shall have free access to the mill or shop for inspection purposes and every facility shall be extended to him for this purpose. Any material or pipe included in any shipment which has been rejected at the mill or shop will be considered sufficient cause for the rejection of the entire shipment.

57.03 CONSTRUCTION OF PIPE. Pipe furnished under these specifications shall be of the full circle riveted type, with lap-joint construction.

(a) Net Length. The length of culvert specified shall be the net length of the finished culvert which does not include any material used to procure and end finish on the pipe. If the average deficiency in length of any shipment of pipe is greater than 1 per cent, the shipment shall be rejected.

(b) Length of Sections. All pipe shall be furnished in the lengths ordered, except that pipe for culverts 26 feet or more in

length may be furnished in sections not less than 12 feet in length, provided all necessary field couplings are furnished free of charge. For small shipments involving less than carload lots, the above requirements may be modified by written authority from the engineer.

(c) Dimensions and Weights. The length of sheets, widths of laps, gauge of the uncoated metal (United States standard gauge), and theoretical weight per lineal foot of the finished culvert shall be as specified in the following table. The dimensions given for diameter of pipe are nominal. The average weight per lineal foot of a finished culvert, exclusive of end fittings, shall not underrun the theoretical weight specified by more than 5 per cent.

Nominal diameter	Length of sheet before forming	Width of lap	Minimum gauge United States Standard	Weight per lineal foot of finished culvert	Minimum gauge connecting bands
Inches	Inches	Inches		Pounds	
12	41	1.5	16	10.5	16
15	50.5	1.5	16	12.9	16
18	60	1.5	16	15.3	16
24	80	2.0	14	25.2	16
30	98	2.0	14	30.9	16
36	117	2.0	12	51.0	14
42 +	137	3.0	12	59.5	14
48 +	156	3.0	12	68.0	14
60	98(2)	3.0(2)	10	108.9	12

+Two sheets may be used by allowing sufficient total sheet lengths to provide for an additional standard lap.

(d) Corrugations. Corrugations shall be not less than 2-1/4 nor more than 2-3/4 inches center to center. The corrugations shall have a depth of not less than 1/2 inch.

(e) Rivets. Rivets shall have the following dimensions:

No. 16 gauge material
(two thicknesses of sheets), 5/16 by 1/2 inch.
No. 16 gauge material
(three thicknesses of sheets), 5/16 by 5/8 inch.
No. 14 gauge material
(two thicknesses of sheets), 5/16 by 5/8 inch.
No. 14 gauge material
(three thicknesses of sheets), 5/16 by 3/4 inch.
No. 12 gauge material
(two thicknesses of sheets), 3/8 by 7/8 inch.
No. 12 gauge material
(three thicknesses of sheets), 3/8 by 3/4 inch
No. 10 gauge material
(two thicknesses of sheets), 3/8 by 7/8 inch.

No. 10 gauge material
(three thicknesses of sheets), 3/8 by 7/8 inch.
No. 8 gauge material
(two thicknesses of sheets), 3/8 by 7/8 inch.
No. 8 gauge material
(three thicknesses of sheets), 3/8 by 1-1/8 inch.

All rivets shall be driven cold in such a manner that the plates shall be drawn tightly together throughout the entire lap. No rivet shall be closer than twice its diameter from the edges of the metal. All rivets shall have a neat, workmanlike, and full hemispherical heads, or heads of a form acceptable to the engineer; shall be driven without bending; and must completely fill the hole. Longitudinal seams shall be riveted with one rivet in each full corrugation. The longitudinal seams of 42-inch pipe and larger shall be double riveted.

Circumferential shop riveted seams shall have a maximum rivet spacing of 6 inches, except that six rivets will be sufficient in 12-inch pipe.

(f) End Finish. If headwalls are not to be constructed, the inlet and outlet ends of all culverts fabricated of 16 or 14 gauge sheets shall be reinforced with rolled ends in a manner approved by the engineer.

(g) Coupling Bands. Field joints shall be made with bands of the same base metal as the culverts, and shall be not less than 7 inches wide for pipes 30 inches and less in diameter, 12 inches for pipe 36 inches to 48 inches in diameter, and 24 inches for pipes 60 inches to 84 inches in diameter, so constructed as to lap an equal portion of each of the culvert sections to be connected. Such bands shall be connected at the ends by angles having minimum dimensions of 2 x 2 x 3/16 inch, and of length equal to full width of band, or by other approved connections of suitable strength. Each connection shall be fastened by at least two bolts not less than 1/2-inch diameter for 7-inch bands, by three bolts for 12-inch bands and by five bolts for 24-inch bands. All angle irons and bolts shall be hot dipped or electro-galvanized.

(h) Workmanship. It is the essence of these specifications that in addition to compliance with the details of construction the completed pipe shall show careful, finished workmanship in all particulars.

Culvert pipe on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship shall be rejected. This requirement applies not only to the individual pipe but to the shipment on any contract as a whole. Among other, the following defects are specified as constituting poor workmanship, and in the presence of any or all of them in any individual culvert pipe, or in general in any shipment, shall constitute sufficient cause for rejection: Uneven laps, elliptical shaping; variation from a straight center line; ragged or diagonal sheared edges; loose, enevenly lined

or spaced rivets; poorly formed rivet heads; unfinished ends; illegible brands; lack of rigidity; bruised, scaled or broken spelter coating; dents or bends in the metal itself.

(i) Field Inspection and Acceptance. The field inspection shall be made by the engineer, who shall be furnished by the contractor with an itemized statement of the sizes and lengths of culvert pipe in each shipment. This inspection shall include an examination of the culvert pipe for deficiencies in length of sheets used, nominal specified diameter, net length of finished culvert pipe, and any evidence of poor workmanship as outlined above. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating. The inspection shall be made promptly upon notification by the contractor of the arrival of the material.

The pipe making up the shipment shall fully meet the requirements of these specifications, and if 25 per cent of the pipe in any shipment fails to meet these requirements the entire shipment may be rejected.

Where samples are taken for chemical analysis and determination of weight of spelter coating, at least one sample from which a specimen 2 1/4 inches may be prepared shall be selected from each ten culverts of a shipment, and not less than three samples shall represent any one shipment.

57.04 CONSTRUCTION METHODS. Culverts under the highway shall be placed so that the minimum distance from finished grade of roadway to the top of the pipe shall be not less than one-half the diameter of the pipe with a minimum of 1 foot.

A trench shall be excavated to the depth and grade established by the engineer, due allowance being made for necessary camber. The bottom of the trench shall be shaped to conform to the bottom of the pipe and to afford a firm and uniform bearing throughout the entire length of the culvert. If, in the opinion of the engineer, the material in the bottom of the excavation is of such a character as to cause unequal settlement along the length of the culvert, the trench shall be dug below the grade given, to such a depth as ordered, and backfilled with gravel or other suitable material and thoroughly tamped or otherwise compacted to insure an unyielding foundation. Where the trench is in solid rock or other hard material, it shall be excavated to a depth of at least 6 inches below the grade established for the bottom of the pipe, and this additional excavation shall be backfilled with suitable material in such manner as to insure a uniform bearing for the entire length of the culvert.

The pipe shall be laid in the trench with the separate sections firmly jointed together and with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in joints which is not thoroughly protected by galvanizing shall be coated with a suitable asphaltum paint.

Selected backfilling material, free from stones, frozen lumps

or clods, shall be placed under and around the pipe and thoroughly tamped or otherwise compacted in place. The trench shall be completely filled and the pipe covered to a depth of at least 1 foot with hand-placed and properly compacted materials before the construction of embankment over the culvert shall proceed in the usual manner.

If trenching is not required, the culvert pipe shall be laid, true to line and grade, on a bed that is uniformly firm throughout its entire length, and the backfilling around and over the pipe shall be completed as specified in the preceding paragraph.

The pipe shall be so shipped and handled as to prevent bruising, scaling or breaking the spelter coating. In no case shall pipes be dragged on the ground.

The vertical diameter of all pipe 48 inches in diameter under fills of 25 feet or more, and of all pipe of more than 48 inches in diameter, shall be elongated approximately 5 per cent before the backfill is made. The compression sills used in this deflection of the pipe shall be of wood and shall extend the full length of the pipe. The bottom sill shall consist of one row of not less than 6-inch x 6-inch timber and the top sill shall consist of two rows of not less than 6-inch x 6-inch timbers placed side by side. Each timber in a sill shall be not less than 10 feet in length. The vertical struts shall be not less than 6-inch x 6-inch timbers and of the proper length to give a uniform deflection of the pipe to the specified elongated diameter. Vertical struts shall be placed not more than 6 feet apart. Caps between the upper sill and vertical struts shall be not less than 6 x 6 x 12 inches in size. Struts shall be left in place for at least one month after completion of the embankment.

57.05 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. This item shall be paid for at the contract unit prices bid per foot of corrugated metal pipe culvert of the several sizes, measured complete in place, which price shall be full compensation for furnishing, hauling and installing the pipe, for preparation of the bed and backfilling and for all material, equipment, tools, labor and incidentals, but shall not be payment for excavation nor for concrete or masonry headwalls.

Should it be determined on construction that the length of any culvert as called for on the plans is insufficient, then the contractor shall provide and place the necessary additional length required at the contract unit prices bid per foot for the appropriate size, but the furnishing and placing of additional connecting bands necessitated because of such change in culvert length, shall be paid for as extra work in accordance with the provisions of Section 9.04 of these specifications.

SECTION 58

RELAYING PIPE CULVERTS

58.01 DESCRIPTION. This item shall consist of the careful removing, cleaning and preserving of pipe from existing pipe culverts and relaying the same as shown on the plans or as designated by the engineer.

58.02 CONSTRUCTION METHODS. The construction methods shall conform to those required in the specifications for the various kinds of pipe laid as hereinbefore specified in Sections 56.04 and 57.04.

58.03 METHOD OF MEASUREMENT. This item shall be measured by the actual number of lineal feet of pipe relaid as directed, complete in place.

58.04 BASIS OF PAYMENT. Relaid culvert pipe, measured as provided above, shall be paid for at the contract unit prices per lineal foot bid for "Relaying Pipe Culvert", of the various types but irrespective of size, which prices shall be full compensation for the removal, cleaning, preservation, hauling and relaying the pipe and backfilling, for any necessary cutting of pipe, for furnishing new coupling bands required, and for all labor, equipment, tools and incidentals necessary to complete the work; except that excavation for the removal and relaying of the pipe shall be measured and paid for as "Culvert Excavation" in accordance with the provisions of Section 14 of these specifications,. and new concrete or masonry headwalls, if required, shall be paid for as a separate item or items.

SECTION 59

REMOVAL OF PIPE CULVERTS

59.01 DESCRIPTION. This item shall consist of the removal of pipe culverts from beneath the existing roadbed or from other locations as may be designated on the plans or by the engineer, and their cleaning and disposal or storage as directed. It does not include the removal of culverts that are to be relaid in the roadway under contract.

59.02 CONSTRUCTION METHODS. Excavation necessary for the removal of pipe culverts may be made by any method that does not involve injury to the pipe. Any pipe that in the course of removal or handling is bent, torn, crushed, or otherwise damaged, shall be replaced by the contractor with an equal length of pipe of the same diameter, quality and condition, or the contractor shall reimburse the State in an amount equivalent to the cost of replacing the damaged pipe with an equal amount of new pipe of the same diameter and quality. Backfill of the excavation occasioned by the removal of the pipe shall be tamped or otherwise compacted to the same degree of compaction as that specified for the adjacent fills.

59.03 METHOD OF MEASUREMENT. This item shall be measured by the actual number of lineal feet of pipe removed as directed.

59.04 BASIS OF PAYMENT. Removal of pipe culverts, measured as provided above, shall be paid for at the contract unit prices bid for "Removal of Pipe Culverts", of the various types, irrespective of size, which price shall be full compensation for the removal, cleaning, preservation and stockpiling of the pipe and backfilling of the excavation and for all labor, equipment, tools, and incidentals necessary to complete the work except that excavation for the removal of the pipe shall be measured and paid for as "Culvert Excavation" in accordance with the provisions of Section 14 of these specifications.

SECTION 60

PIPE SYPHONS

60.01 DESCRIPTION. This item shall consist of furnishing and placing, as directed, syphon pipe of galvanized corrugated metal, or of reinforced concrete, of the sizes and dimensions shown on the plans.

60.02 MATERIALS. (a) Galvanized corrugated metal syphon pipe shall conform to the specifications for corrugated metal pipe as hereinbefore contained in Section 57. In addition, the seams and joints shall be close riveted and soldered water-tight. Where field connections are necessary, they shall be made water-tight by the addition of a concrete collar composed of Class D concrete, or approved 1:3 cement mortar cast around the joint. This collar shall be at least 6 inches thick and shall extend at least 1 foot on each side of the joint. The cement mortar and the components thereof shall conform to the requirements for cement mortar as contained in Section 61. Field connections will not be allowed within 15 feet of the centerline of the road.

In lieu of field connections constructed with concrete collars, necessary field connections may be constructed as follows: The corrugated metal connection bands shall be 12 inches wide for all diameters of syphon pipe. These bands, however, will not be connected by angle lugs as described in Section 57.03 (g) of these specifications, but will be tightened around the periphery of the syphon pipe by means of four round mild steel galvanized rods, 7/16-inch or 1/2-inch diameter, which have been formed to the circumference of the pipe, threaded for at least 5 inches at both ends of the rods, and of sufficient length for insertion through a two-holed tank lug and fastened by means of galvanized hexagonal nuts. There shall also be furnished with each connection band sufficient asphalt compound of such consistency that it may be formed by hand in the field into asphalt "ropes" to fill the second corrugation on the end of each pipe section before the band is placed around the pipe, thus providing a water-tight bond between the syphon pipe and the connection band. There shall also be furnished a gasket of rubber, or other approved material, for insertion under the laps of the connection band.

(b) Reinforced concrete syphon pipe shall meet requirements as set forth by the American Society of Testing Materials under Serial Designation C 76 or by the Association of State Highway Officials under Specification M 41. In addition, syphon pipe shall be furnished in various shapes and lengths to conform to design as shown on the plans, and pipe sections shall be so constructed as to afford a water-tight connection that will be satisfactory to the engineer. Either lock joint, copper strip or rubber band type of standard make will be satisfactory. On lock joint or copper strip type a grout made of one part Portland cement and two parts sand shall be used to make a water-tight connection.

60.03 CONSTRUCTION METHODS. (a) Galvanized corrugated metal syphon pipe shall be laid in accordance with the methods described in Section 57.04 for galvanized corrugated metal pipe culvert.

(b) Reinforced concrete syphon pipe shall be laid to lines as staked which shall be a minimum of 12 inches from the top of pipe to the lowest elevation of side ditch so that none of the pipe will be exposed in the section.

A trench shall be excavated to the depth and grade established by the engineer. The bottom of the trench shall be shaped to conform to the bottom of the pipe and to afford a firm and uniform bearing throughout the entire length of the syphon. If, in the opinion of the engineer, the material in the bottom of the excavation is of such character as to cause unequal settlement along the length of the syphon, the trench shall be dug below the grade given, to such a depth as ordered, and backfilled with gravel or other suitable material and thoroughly tamped or otherwise compacted to insure an unyielding foundation. Where the trench is in solid rock or other hard material, it shall be excavated to a depth of at least 6 inches below the grade established for the bottom of the pipe, and this additional excavation shall be backfilled with suitable material in such a manner as to insure a uniform bearing for the entire length of the syphon.

The pipe shall be laid in the trench with the separate sections firmly jointed together, with all connections made with the exception of inside grouting. Grouting thoroughly finished to a smooth surface on the inside of the pipe shall not be made until fill is completed and allowed to settle for a period of not less than two weeks.

Selected backfilling material, free from stones, frozen lumps and clods, shall be placed under the pipe. After the bedding has been prepared and the pipe installed, selected material from excavation or borrow shall be placed alongside the pipe in layers not exceeding 6 inches in depth and compacted thoroughly so that on each side of the pipe there shall be a berm of thoroughly compacted material at least as wide as the external diameter of the pipe, except insofar as undisturbed material obtrudes upon this area. Each layer shall be compacted by rolling or by tamping with mechanical rammers, or by hand tamping with heavy iron tampers, the tamping faces of which shall not exceed 25 square inches in area, special care being taken to compact the fill thoroughly under the haunches of the pipe. This method of filling and compacting shall be continued until the embankment has reached an elevation 8 inches above the top of the pipe.

The pipe shall be shipped and handled so as to prevent chipping or breaking and no pipe shall be placed showing any defect at the joints that would not allow a perfect connection.

60.04 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. Pipe syphon shall be measured by the lineal foot of pipe complete in place. This item shall be paid for at the contract unit price per foot bid for the different diameters of pipe, which price and payment shall be full compensation for furnishing, hauling and installing the pipe, and for all materials, equipment, tools, labor and incidentals necessary to complete the item, but shall not constitute payment for excavation or headwalls.

SECTION 61

CEMENT RUBBLE MASONRY

61.01 DESCRIPTION. This item shall consist of cement rubble masonry composed of approved stones laid in mortar beds and constructed in conformity with the plans or as directed in writing by the engineer.

61.02 MATERIAL. The Portland cement and water for the mortar shall be such as to conform with the respective requirements for these materials as contained in the specifications hereinbefore given for concrete.

The stone for rubble masonry shall be clean, hard, and of a kind known to be durable. All weathered stone shall be rejected. The individual stones, except for filling joints, shall have a thickness of not less than 5 inches and a width of not less than 1-1/2 times the thickness or less than 12 inches. No stone, except headers, shall have a length less than 1-1/2 times its width.

Mortar sand shall consist of clean, hard, durable, uncoated particles, free from lumps of clay, soft or flaky material, loam and organic matter. At the time of use, it shall be free from lumps of frozen material.

Mortar sand shall be uniformly graded from coarse to fine, and when tested by means of laboratory sieves shall meet the following requirements:

Passing a No. 4 Sieve	100%
Passing a No. 10 Sieve	85-100%
Passing a No. 20 Sieve	50- 80%
Passing a No. 50 Sieve	15- 40%
Passing a No. 100 Sieve	0- 10%

Mortar sand, when subjected to the mortar strength test, shall have a tensile strength, at the age of 7 days and 28 days, of not less than 75 per cent of that developed by mortar of the same proportions and consistency, made of the same cement and standard Ottawa sand.

Mortar sand shall be free from injurious organic impurities. Sand subjected to the color test for organic impurities and producing a color darker than the standard shall be rejected unless it passes the mortar strength test. Not more than 3 per cent shall be removed by the decantation test.

61.03 CONSTRUCTION METHODS. All rubble masonry shall be constructed by experienced workmen. Selected stones, roughly squared and pitched to lines, shall be used at all angles and ends of walls. All stones shall be thoroughly wet prior to laying and be laid with practically horizontal beds; large flat stones shall be selected for the bottom courses. All courses shall be laid with bearing beds parallel to the natural bed of the material. All stones shall be fully bedded in Portland cement mortar mixed in the proportion of

one part cement to three parts of sand and shall be so placed as to break joints at least 6 inches and form a firm bond. Mortar which is not used within 30 minutes after water has been added shall be wasted. Retempering of mortar will not be permitted.

For mortar the sand and cement shall first be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains a consistency such that it can be easily handled and spread with a trowel.

Headers shall be distributed uniformly through the walls of the structure so as to form at least one-fifth of the exposed surfaces. They shall be of such lengths as to extend through the face wall into the backing at least 12 inches, and where a wall is less than 18 inches in thickness the headers shall extend entirely through from front to back face.

The interior of the walls shall be built up so that the stones of which it is composed will be bonded, and so that no open spaces will be left. Horizontal joints in the face shall not exceed 1 inch in thickness and vertical joints shall not exceed 2 inches in width. No spalls shall be used in the face of a wall, and the face stones shall be so well bedded that none will be needed. Walls shall be provided with weep holes wherever called for on the plans or directed by the engineer. If a stone is loosened after the mortar has set it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

This class of masonry shall be finished with a concrete coping or with a top course consisting of roughly shaped stones. Copings, bridge seats, and backwalls, unless otherwise specified, shall be of Class A concrete, which shall be not less than 8 inches thick and wide enough to cover the full width of the wall and shall be cast in place. If a stone coping is specified, the stones shall be not less than 8 inches thick, from 1-1/2 to 4 feet long and wide enough to cover the top of the wall, set in full mortar beds as shown on the plans.

After the stone is all laid as above specified the face joints shall be thoroughly cleaned of all mortar to a depth of 1 inch. The joints shall then be wetted and pointed with Portland cement mortar mixed in the proportion of one part of cement to one part of sand.

No masonry shall be laid or pointing done in freezing weather nor when stone contains frost, without the permission of the engineer, and the exercise of such precautions as he may direct. In hot or dry weather the masonry before and after pointing shall be satisfactorily protected from the sun and kept wet for a period of at least 3 days before completion. Any work damaged by frost or because of improper protection from the sun shall be removed and replaced at the contractor's expense.

61.04 BASIS OF PAYMENT. This work shall be measured in accordance with the dimensions shown on the plans, except where changes are

ordered by the engineer, and will be paid for at the unit price bid per cubic yard for cement rubble masonry complete in place, which price and payment will be full compensation for the concrete coping or stone top course, whichever is required, and for all materials, equipment, tools, labor and incidentals necessary to complete the item.

SECTION 62

DRY RUBBLE MASONRY

62.01 DESCRIPTION. This item shall consist of the construction of dry rubble masonry composed of approved stones laid without mortar so as to fit neatly and firmly, and built in conformity with the plans or as directed by the engineer.

62.02 MATERIAL. The stones shall be sound, durable, free from structural defects, and shall be free from rounded, worn or weathered surfaces, and clean of earth, clay or other foreign substances. No stone shall be used which has a minimum thickness of less than 5 inches, a minimum width of less than 12 inches, or which is less than 1/2 cubic foot in volume. In the lower course of a dry rubble wall no stone shall be used which has a volume of less than 1 cubic foot. Small stones may be used for pinning and filling interstices in the heart of the wall.

62.03 METHOD OF CONSTRUCTION. All dry rubble masonry shall be constructed by experienced workmen. The stone shall be roughly dressed on beds and joints and laid on natural beds, being well bonded and breaking joints at least 6 inches. Walls need not be built in courses, but shall be so constructed that no part is materially in advance of the other. In all cases the base thickness of dry walls shall be at least half the height, which shall not exceed 8 feet. Headers shall be distributed uniformly throughout the wall, so as to form approximately one-fifth of the exposed faces, and shall extend through the face wall and into the backing at least 12 inches. Where a wall is less than 18 inches thick, the headers shall extend entirely through from front to back face. Where the wall is more than 18 inches thick, the headers shall either extend entirely through or overlap at least 6 inches. Walls shall be built up so as to leave no appreciable open spaces, and only sufficient spalls shall be used to wedge the larger stones in place. This class of masonry shall be finished with a top course or coping consisting of roughly shaped stones not less than 6 inches thick, from 1-1/2 to 4 feet long, and wide enough to cover the top of the wall, carefully laid in solid beds.

62.04 BASIS OF PAYMENT. This work will be measured in accordance with the dimensions shown on the plans, except where changes are ordered by the engineer, and will be paid for at the unit price bid per cubic yard for dry rubble masonry complete in place, which price and payment will be full compensation for the coping and all materials, equipment, tools, labor and incidentals necessary to complete the item.

SECTION 63

GROUTED RIPRAP

63.01 DESCRIPTION. This work shall consist of a protective covering of approved stone, rock fragments, or waste concrete slabs (hereinafter referred to as stone) hand-placed and grouted, and constructed in accordance with the requirements of the contract. The minimum thickness shall be 9 inches or as otherwise specified.

63.02 MATERIALS. (a) The stone shall be sound and durable, not less than 3 inches in thickness nor contain less than 1/2 of a cubic foot in volume. No stone shall be used that does not extend through the riprap.

(b) The grout shall consist of one part of Portland cement and three parts of sand, thoroughly mixed with water to produce grout of a thick, creamy consistency.

(c) Mortar sand shall consist of clean, hard, durable uncoated particles free from lumps of clay, soft or flaky material, loam and organic matter. At the time of use it shall be free from lumps of frozen material.

Mortar sand shall be uniformly graded from coarse to fine and when tested by means of laboratory sieves shall meet the following requirements:

Passing a No. 4 Sieve . . .	100%
Passing a No. 10 Sieve . . .	85-100%
Passing a No. 20 Sieve . . .	50- 80%
Passing a No. 50 Sieve . . .	15- 40%
Passing a No. 100 Sieve . .	0- 10%

Mortar sand, when subjected to the mortar strength test, shall have a tensile strength at the age of 7 days and 28 days of not less than 75 per cent of that developed by mortar of the same proportions and consistency made of the same cement and standard Ottawa sand.

Mortar sand shall be free from injurious organic impurities. Sand subjected to the color test for organic impurities and producing a color darker than the standard, shall be rejected unless it passes the mortar strength test.

63.03 METHOD OF CONSTRUCTION. Unless otherwise specified, the slopes upon which the grouted riprap is to be placed shall conform to the slopes of the cross-sections of the embankment as shown on the plans. The grouted riprap shall commence in a trench 18 inches below the toe of the slope of the embankment (unless otherwise specified) and shall progress upward. The ends of riprap walls shall be keyed into the earth or embankment slopes a minimum of 24 inches from the outer face of the riprap and for the full height of the riprap wall. Each stone shall be laid by hand perpendicular to the slope and shall be firmly bedded against the slope and against adjoining stone, and shall be laid with well-broken joints. Care shall be taken to keep earth and sand from filling the spaces between

the stones.

After the stone has been placed, the voids shall be filled with spalls or small stones in such a manner that all stones are tightly wedged or keyed. The finished surface shall present an even, tight and reasonably plane surface varying not more than 3 inches from the required contour.

Crevices shall be completely filled with grout to a minimum depth of 3 inches, after which the surface shall be swept with a stiff broom. No grouting will be permitted in freezing weather. In hot, dry weather, the work shall be protected from the sun and kept moist for at least 3 days after grouting.

63.04 METHOD OF MEASUREMENT. This work shall be measured to the nearest 1/2 square yard of surface.

63.05 BASIS OF PAYMENT. This work shall be paid for at the unit price bid per square yard for grouted riprap complete in place, which price and payment shall constitute full compensation for all necessary excavation, backfilling, materials, equipment, tools, labor and incidentals necessary to complete the item.

SECTION 64

RIPRAP, RANDOM AND HAND LAID

64.01 DESCRIPTION. This item shall consist of stone placed, as a protective covering, along the slopes of embankments, around culvert inlets or outlets, around foundations or such other places as may be indicated in the plans or directed by the engineer. It shall be placed in conformity with these specifications and in conformity with the lines, grades and dimensions shown on the plans or required by the engineer.

64.02 MATERIALS. The stone or rock fragments shall be hard, sound and durable and of such a quality that they will not disintegrate on exposure to water or weathering.

(a) Hand Laid Riprap. The stone for this work shall be sound, durable stone, not less than 3 inches thick nor containing less than 1/2 a cubic foot in volume or weighing less than 75 pounds. For hand-laid riprap, no stone shall be used that does not extend through the revetment.

(b) Random Riprap.

(Type A). At least 80 per cent by weight of the stone shall have a volume of not less than 1 cubic foot or a weight of not less than 150 pounds.

(Type B). Not less than 40 per cent of the total volume shall be composed of stones having a volume of not less than 4 cubic feet and not more than 20 per cent of the total volume may be composed of stones having a volume of less than 1 cubic foot.

64.03 METHOD OF CONSTRUCTION. (a) Hand-Laid Riprap. A trench of the design and dimensions shown in the plans or on the standard detail plates shall be excavated along the toe of the slope to a stable foundation or carried to a point below scour, but in no case less than 2 feet below the toe of the slope and a course of the largest stone placed therein. The slope protected shall not be steeper than the angle of repose of the material unless otherwise indicated. The stones shall be placed with their beds at right angles to the slope and so far as practicable the larger stones shall be used in the lower courses. They shall be laid in close contact so as to break joints and so placed that each stone will rest on the slope of the embankment and not wholly on the stone below it. The spaces between the larger stones shall be filled with spalls securely rammed into place. The finished work shall present an even, tight and reasonably plane surface, varying not more than 3 inches from the required contour.

Where the thickness of the riprap is not indicated on the plans, it shall be at least 12 inches measured perpendicular to the slope.

(b) Random Riprap. The stone, graded so that the smaller stone is uniformly distributed throughout the mass, shall be handled or dumped on the designated slopes to form the cross section

shown on the plans. The rock shall be manipulated sufficiently to secure a regular surface and mass stability. Where the thickness of the riprap is not shown on the plans it shall be at least 18 inches measured perpendicular to the slope.

Unless otherwise ordered by the engineer, riprap shall extend from 2 feet below the toe of the slope to mean high water elevation.

64.04 METHOD OF MEASUREMENT. The yardage to be paid for shall be the number of cubic yards of hand-laid riprap or random riprap, measured in place, completed and accepted. The work shall be measured, when complete in place as ordered, to the nearest 1/2 cubic yard.

64.05 BASIS OF PAYMENT. This work will be paid for at the unit price bid per cubic yard for hand-laid riprap or random riprap, as the case may be, complete in place, which price and payment shall constitute full compensation for all necessary excavation, backfilling, materials, equipment, tools, labor and incidentals necessary to complete the item.

SECTION 65

HAND-LAID ROCK EMBANKMENT

65.01 DESCRIPTION. This item shall consist of strengthening embankments, when slopes have been necessarily steepened, by the use of hand-laid rock which shall be constructed according to the lines and dimensions given by the engineer before work is started.

65.02 MATERIAL. The stone for this work shall be sound and durable, not less than 1/2 cubic foot in volume, and may be taken from the adjacent excavation.

65.03 METHOD OF CONSTRUCTION. An adequate footing shall first be excavated in stable ground along the toe of the slope of the proposed fill. The selected stone material shall be placed by hand on this prepared footing and additional stone laid up to the width and dimensions directed. Care shall be taken to have the stones bonded to some extent and securely bedded. Spalls shall be used to fill voids. The hand-laid rock embankment thus constructed shall be backed by the usual embankment placed as prescribed under earthwork.

65.04 METHOD OF MEASUREMENT. Hand-laid rock embankment shall be measured by the cubic yard when complete in place as ordered. The excavation for the footing prescribed shall not be measured.

When stone material for this item is obtained from roadway or other prescribed excavation, no deduction from the excavation yardage for the stone so used shall be made.

65.05 BASIS OF PAYMENT. This item shall be paid for at the unit price bid per cubic yard for hand-laid rock embankment complete in place, which price and payment shall be full compensation for selecting and placing by hand the material measured, and for all footing excavation, equipment, tools, labor, and incidentals necessary to complete the item.

SECTION 66

UNDERDRAINS

66.01 DESCRIPTION. This item shall consist of the construction of underdrains at such places as are shown on the plans or as are designated by the engineer. They shall have suitable outlets in culverts or such other outlets as to drain water entirely away from the road and protect the outlet of the drain. They shall be constructed directly under the gutter or ditch or under the roadway to the line and grade furnished by the engineer and in accordance with the plans and these specifications.

66.02 MATERIALS. Pipe for underdrains shall be concrete, clay, perforated corrugated galvanized sheet metal, whichever is shown on the plans and called for in the bid schedule, and shall be of the size called for.

(a) Concrete Pipe. Concrete pipe for underdrains shall conform to the requirements for nonreinforced concrete pipe as given in Federal Specification SS-P-371, except that the absorption test will not be required and provided that the strength in pounds per linear foot shall not be less than 2,000 D. D is the symbol for the nominal inside diameter of the pipe in feet.

Concrete pipe of porous, perforated, or other designs will be accepted provided the pipe meets the strength requirement given above and provided further that, in the opinion of the engineer, the design is such as to assure performance at least equal to that of the pipe above specified.

(b) Clay Pipe. Clay pipe for underdrains shall conform to the requirements of Federal Specification SS-P-361, except that the absorption test will not be required and provided that the strength in pounds per linear foot shall not be less than 2,000 D. D is the symbol for the nominal inside diameter of the pipe in feet.

Clay pipe of porous, perforated, or other designs will be accepted provided the pipe meets the strength requirement given above and provided further that, in the opinion of the engineer, the design is such as to assure performance at least equal to that of the pipe above specified.

(c) Perforated Corrugated Galvanized Sheet Metal Pipe. This pipe shall conform to the requirements of Corrugated Galvanized Sheet Metal Culvert Pipe; provided, however, that where 6- or 8-inch diameter pipe is called for, the pipe shall meet the said requirements in all respects or shall meet those requirements with the following modifications:

1. Shape and seams. Pipe shall be of the corrugated full circle type having securely locked or welded seams. Locked seams shall be turned under and pressed down smoothly so as not to affect the shape and nominal diameter of the pipe.

2. Corrugations. Corrugations shall be not less than 1-3/8

inches nor more than 1-7/8 inches center to center, measured at right angles to the direction of the corrugations. The depth of the corrugations shall be not less than 1/4 inch.

3. Gauge and weight. The metal shall be 18 gauge or heavier and the average weight per linear foot of finished pipe shall be 3.7 pounds or heavier for 6-inch, 5 pounds or heavier for 8-inch pipe. Underruns not exceeding 5 per cent will be permitted.

4. Perforations. The perforations shall be at least 1/4 of an inch in diameter as measured on the finished pipe, and shall be placed in the inside crests of all corrugations. The rows of perforations shall be spaced on approximately 1-inch centers, measured circumferentially.

5. Connecting bands. Connecting bands shall have corrugations that mesh with the corrugations in the pipe, and shall be fastened with galvanized bolts. Other equally effective methods for connecting the sections may be used if approved by the engineer.

(d) Drains at Weep Holes. Around weep holes in wing and abutment walls and culvert side walls there shall be placed at least 1/3 of a cubic yard of coarse gravel or broken stone not less than 2 feet in any dimension. All form boards or other obstructions shall be removed from the drains before backfill is made. The coarse gravel or broken stone shall be clean and not less than 1 inch nor more than 3-1/2 inches in size. The stone or gravel shall be thoroughly tamped after being placed.

66.03 CONSTRUCTION METHODS. The trench shall be excavated to the width, line and grade given by the engineer, the depth of trench to vary from 2-1/2 to 4-1/2 feet below the finished surface at the top of the trench where the construction is under the gutter or ditch or under the roadway, and to depths required for proper drainage at other locations, provided, however, that wherever the plans show the required depth, such depth shall govern the construction. A 2-inch bed (unless otherwise shown on the plans, in which case the dimension on the plan shall govern) of stone or gravel, all passing a 1-inch sieve and retained on the No. 4 sieve, shall be spread in the bottom of the trench throughout its entire length and brought to a uniform grade.

Pipe of the kind and size required shall be embedded firmly in the bottom course of stone. Bell and spigot pipe shall be laid with the bell ends upgrade and the spigot ends fully entered in the adjacent bells but not mortared or otherwise closed to the desired infiltration of water. The joints shall be covered with two-ply tar paper strips not less than 6 inches in width and of sufficient length to permit the ends being turned outward and laid flat on the bottom course of stone on either side of the pipe for a distance of 3 inches.

Unless otherwise shown on the plans, or directed by the engineer, perforated pipe shall be laid with the perforated side of the pipe down and separate sections shall be firmly joined together.

After the pipe has been laid and has been inspected and approved by the engineer, clean gravel, or broken stone filling, all passing a 3-inch sieve and retained on a 3/4-inch sieve (unless otherwise shown on the plans, in which case the plans shall govern) shall be placed carefully, so as not to displace the pipe or joint covering around and over the pipe, to within 12 inches of the finished ground surface unless otherwise shown on the plans, in which case the plans shall govern. The upper 12 inches of the trench shall then be filled with suitable material of either the porous or impervious type as shown on the plans or as ordered by the engineer. All filling shall be tamped firmly.

Where shown on the plans, the top surface of the gravel backfill shall be shaped as shown and sealed with a course of mortar approximately 1 inch in thickness. The mortar shall consist of Portland cement and sand mixed with water in the proportions of one part of cement to five parts of sand. The materials for the mortar shall be subject to approval by the engineer before being used.

Where blind drains are called for, they shall be dug to the cross section shown on the plans and to the depth staked by the engineer. The trench thus prepared shall be filled with stones, broken stone, or gravel of the approximate sizes shown on the plans, or required by the engineer, to within 12 inches of the finished ground surface. The upper 12 inches of the trench shall then be filled with suitable material of either the porous or impervious type as shown on the plans or required by the engineer. Both stones and surface filling shall be firmly tamped.

66.04 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. (a) Vitrified tile underdrain, porous tile underdrain, and blind drain shall be measured by the lineal foot and shall be paid for at the unit price bid per lineal foot for the item.

(b) Gravel or broken stone for drains at weep holes, unless otherwise specified, shall be paid for at the unit price bid per cubic yard for unclassified excavation, or if the drains are below the natural ground surface the gravel or broken stone shall be considered as a part of the backfill required and the cost of placing such material shall be included in the unit bid price for excavation for structures.

(c) Excavation work and backfill will be measured and paid for as "Structure or Culvert Excavation" in accordance with the provisions as hereinbefore stated.

The unit price bid for underdrains of the several classes shall be for the items complete in place including the furnishing of all materials, equipment, tools and labor and the performance of all work necessary or incidental to the proper completion of the item, or items.

SECTION 67

METAL DITCH LINING AND FLUME

67.01 DESCRIPTION. This item shall consist of the construction of flumes or the installation of semi-circular metal ditch lining where it is necessary to adjust or protect irrigation or drainage system because of interference with highway construction.

67.02 MATERIALS. (a) Metal flume and ditch lining shall be made of 20 gauge (U. S. Standard) galvanized ferrous sheets and shall be of semi-circular type. The base metal and spelter coating shall comply with the physical and chemical requirements as specified hereinbefore for culvert pipe in Section 57. The completed flume or ditch lining shall consist of formed and beaded sheets, carrier rods, compression bars, shoes, anchor rods, nuts and washers, all of which shall be galvanized. The joints between successive sheets comprising the lining shall be designed to provide rigidity and water tightness, and they shall offer the least possible resistance to flow. Carrier rods, compression and anchor bars, shoes, nuts, washers and hanger plates shall have a galvanized coating of not less than 3/4 ounce of commercially pure zinc per square foot of surface. The coating shall be capable of withstanding three 1-minute and one 1/2-minute immersions in a standard testing solution of copper sulphate without showing any trace of metallic copper on the steel.

(b) The lumber used shall be No. 1 common, graded according to the latest Standard Grading and Dressing Rules of the West Coast Lumbermen's Association, or equivalent grades of other regional associations of lumber manufacturers which conform to the basic provisions of the "American Lumber Standards" as adopted by the U. S. Department of Commerce. The use of the following listed species of wood will be allowed: Douglas Fir, West Coast Hemlock, Western Red Cedar, Ponderosa Pine and Larch.

67.03 CONSTRUCTION METHODS. The framing, erection and completion of the timber portions of the structure shall be done in conformity with the appropriate provisions for "Timber Structures" as hereinbefore specified in Section 46 and in accordance with the detail plans.

The metal ditch lining and metal flume shall be laid true to line and grade, on a bed that is uniformly firm throughout its entire length. The separate sections shall be firmly joined together with the outside laps of circumferential joints pointing upstream.

67.04 METHODS OF MEASUREMENT AND BASIS OF PAYMENT. (a) Lumber in flumes shall be measured and paid for as hereinbefore provided for in Sections 46.05 and 46.06, "Timber Structures."

(b) Metal flume shall be measured by the lineal foot of metal flume complete in place and shall be paid for at the unit contract price bid for this item, which price and payment shall be full compensation for all materials (including all fittings such as carrier rods, compression and anchor bars, shoes, nuts, washers, etc.),

tools, labor and equipment and for the performance of all work necessary or incidental to the proper completion of the item.

(c) Metal ditch lining shall be measured by the lineal foot of ditch lining complete in place and shall be paid for at the unit contract price bid for this item, which price and payment shall be full compensation for furnishing, hauling, and installing the lining; for preparation of the bed and backfilling; for excavating, installing and backfilling for anchor rods and dead men; and for all materials (including wood carrier beams, anchor rods, dead men, shoes, nuts, bolts, stringers, etc.), equipment, tools, labor and incidentals necessary to complete the item.

SECTION 68

WOOD SLAT SNOW FENCE

68.01 DESCRIPTION. This item shall consist of the erection of snow fence, in accordance with the standard design for woven wire wood slat snow fence, at the locations shown on the plans or where directed by the engineer.

68.02 MATERIAL. Slat snow fencing shall consist of 1/2-inch by 1-1/2-inch by 4 feet wooden slats woven together with five cables, each cable consisting of two galvanized wires not smaller than 12-1/2 (American Steel and Wire) gauge. The slats shall be spaced 2 inches apart. Each wire cable shall have two complete turns in each weave in each space between the slats, and at the outside end of each roll there shall be left 1 foot of untwisted cable (two wires) from which samples may be taken for testing.

The fence shall be put up in rolls of from 50 to 100 feet as ordered. Fabric is to be tightly woven and wires forced into slats in such a manner as to hold them tightly. Fence shall be stretched after weaving and before being placed in rolls.

All wires shall be basic open hearth galvanized steel. The average diameter of the uncoated or stripped wire shall be .0985 inch, plus or minus 0.003 inch. The wire shall show no sign of fracture and no flaking of the spelter when wound about a No. 1 mandrel two turns at the rate of fifteen turns per minute. Fabrication shall be done so as not to damage spelter coating or impair the tensile strength of the wire. The wire shall carry a minimum of 0.6 ounces spelter coating per square foot and shall be capable of withstanding three 1-minute and one 1/2-minute immersions in a standard solution of copper sulphate without showing any trace of metallic copper on the steel. Tests shall be run according to tentative methods adopted by the American Association of State Highway Officials under designations T-65 Section (b) and T-66 with subsequent revisions.

All slats shall be made from good sound merchantable wood except that basswood, poplar, cottonwood, lodgepole, or spruce will not be permitted. The slats shall be No. 1 grade conforming to the grading for No. 1 dry lath as specified for Douglas Fir in the West Coast Lumbermen's Association Standard Grading and Dressing Rules. They shall be given a waterproofing and preservative treatment by being immersed in Grade 1 hot creosote oil or a hot solution of red oxide of iron as approved by the engineer.

Posts used in the construction of woven wire wood slat snow fence shall be steel posts 7 feet long and furnished without anchor. Posts shall be given at least one coat of approved paint. The section form of posts may be tubular, tee, equal angle, tee-rail or modified channel provided that all posts weigh at least 1.33 pounds per lineal foot.

68.03 METHOD OF CONSTRUCTION. The snow fence shall be erected at locations shown on the plans or specified by the engineer. The posts

shall be driven into the ground to the depth indicated on the standard plan and the wood slat fencing material shall be tightly stretched and securely wired to the posts. End posts shall be guyed in three directions and intermediate posts shall be guyed as indicated on the plans or as directed by the engineer.

68.04 METHOD OF MEASUREMENT. Wood Slat Snow Fence shall be measured by the lineal foot from outside to outside of end posts.

68.05 BASIS OF PAYMENT. This item shall be paid for at the contract unit price bid per lineal foot for "Wood Slat Snow Fence" measured complete in place from outside to outside of end posts, which price and payment shall be full compensation for the furnishing of all materials, equipment, tools and labor and for the performance of all work necessary or incidental to the proper completion of the item.

SECTION 69

GUARD RAIL AND GUIDE POSTS

69.01 DESCRIPTION. This item shall consist of furnishing and erecting multiple or single-rail guard rail, or guide posts of either rustic, rough-sawed, surfaced and painted timber or concrete as called for on the plans or directed by the engineer, and shall conform in all respects to the requirements of the plans and specifications.

69.02 MATERIALS. The railing shall be of Douglas Fir, Ponderosa Pine, Northern White Cedar, Western Red Cedar or Larch. Guard rail posts and guide posts may be of the same species except that where posts are specified to be treated by the non-pressure or open tank methods, only fir, larch or cedar may be used.

Round or rustic posts shall be straight, sound, and free from defects of all kinds, and shall be cut from live trees not less than 30 days in advance of use, but not exceeding 1 year. All bark shall be peeled and the logs trimmed smooth of all knots and projections.

Sawn posts and rails shall be equal to the grade defined as "Select Merchantable" by the West Coast Lumbermen's Association grading rules or comparable grades under the Western Pine Manufacturer's grading rules, for timber originating in the intermountain areas, except that boxed heart will not be permitted in sawn posts. Sawed railing shall be of sufficient length to span two panels, except on curves. Where surfaced lumber is called for on the plans, it shall be surfaced four sides and the dimensions indicated shall be construed to mean the nearest commercial size.

Where pressure treatment is specified, posts for guard rail, unless otherwise shown on the proposal form, shall be treated by a standard pressure method to meet the requirements for creosote, zinc chloride, zinc meta arsenite, chromated zinc chloride, or Wolman Salts preservative treatments as specified for these types of treatment under Section 54 of these specifications. Use of creosote treatment will not be permitted where painting of posts is specified. Chamfering or other necessary framing, and boring of bolt holes shall be done prior to treating.

When called for by the special provisions, the posts shall be treated for preservation by the non-pressure or open-tank method. The type of toxic agent to be used will be designated by the special provisions. Timber to be treated shall be cut and framed prior to treatment, and any necessary cutting thereafter will be retreated by brushing with the preservative solution. At the time of treating all timber shall have been air- or kiln-dried to a moisture content not exceeding 20 per cent, based on oven-dried wood.

The temperature of the preservative and the treating time shall be within the limits prescribed by the manufacturers of the toxic agent; provided, however, the portion of the lumber or timber to be treated shall be kept fully submerged in the preservative solution not less than 20 minutes times the square of one-half the minimum dimension of the timber in inches.

In all cases, the preservative shall be a non-aqueous solution made up of an oil or oil-like solvent or carrier and of oil-soluble chemical or chemicals, free of water. It shall dry without leaving a residue or color that will be deleterious to subsequent painting or varnishing.

The solvent or carrier shall conform to the recommendations of the manufacturer of the toxic agent and shall be water repellent, volatile and combine the properties of both a penetrant and a spreader.

The toxic chemical shall be fully dissolved in the solvent or carrier and shall remain in solution without separation at working temperatures. Its solubility in water shall not exceed 35 parts per million at 77 degrees F. It shall possess low volatility and the vapor pressure shall not exceed 1.0 mm. of mercury at 100 degrees C.

The concentration of the toxic chemical or chemicals in the solvent shall not be less than 5 per cent by weight.

Unless otherwise provided by the plans or special provisions, preservative treatment, as outlined above for posts for guard rail, guide posts or similar items, shall be limited to that portion of the post to be placed in the ground and extending to a point 9 inches above thereof.

Paint used in painting wood guard rail shall conform to the specifications for paints for woods as hereinafter set forth in Section 71.

All metal fittings, except nails, shall be galvanized by the Hot Dip Method and shall have a continuous coating of pure zinc of a uniform thickness so applied that it will adhere firmly to the surface. It shall be capable of withstanding four immersions in a standard testing solution of copper sulphate without showing any trace of metallic copper on the steel. The first three immersions shall be for a period of 1 minute each and the fourth immersion for a period of 1/2 minute.

PRECAST CONCRETE POSTS. Precast concrete posts shall conform to the design shown on the plans for the particular type or design of guard rail or guide posts specified.

Portland cement, water and reinforcing steel shall meet the requirements of these specifications. The aggregates used in the concrete shall meet the grading requirements for class "D" concrete, so proportioned as to give a 28-day strength of not less than 2,800 pounds per square inch when tested by A.A.S.H.O. Method T-22. Curing shall be done as prescribed for bridge handrails.

69.03 METHOD OF CONSTRUCTION. Untreated posts shall first be painted with three coats of approved black paint at their butt or lower ends as shown on the plans to a point 8 inches above the ground line. The posts shall be set vertically to the depth shown on the plans. They shall be maintained in accurate alignment while

the post holes are backfilled with suitable material and thoroughly tamped in layers. Posts and railings shall be so shaped or notched that satisfactory contact surfaces will be obtained where rails are secured to the posts. All rails shall be squarely butt-jointed at posts.

Unless otherwise specified, untreated sawed and surfaced guard rail posts shall be painted above a point 8 inches above the ground with three coats of approved white paint as hereinbefore specified in Section 46.04, "Painting Untreated Timbers." Non-pressure treated and posts that are pressure-treated by all methods except creosote treatment, shall be painted above the ground line with three coats of approved white paint. Painting of creosote pressure-treated or concrete posts will not be required.

If the construction involves the use of a laminated wood type of rail, the first and second coats of white paint shall be applied to the posts and to all surfaces of each member of the laminated rail prior to assembly.

The specifications for materials, erection and painting for guard rail posts shall also apply to guide posts.

69.04 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. Guard railing shall be paid for at the price bid per linear foot of wood guard rail complete in place, measured from outside to outside of end posts; the price bid shall be full payment for all posts and rails; all materials, including nails, bolts, drift pins, preservative treatment if called for, paint; all excavation and backfilling; all equipment, tools, labor and incidentals.

Guide posts shall be paid for at the unit price bid per post complete in place, which price shall be full payment for all materials, equipment tools and labor and for the performance of all work necessary or incidental to the proper completion of the item, including all excavation, backfilling, preservative treatment if called for, painting and erection.

SECTION 70

WIRE CABLE GUARD RAIL

70.01 DESCRIPTION. This item shall consist of the furnishing and placing of wire cable guard rail consisting of wire cable and necessary fittings supported by wood posts, erected as may be indicated or directed and in accordance with the plans and specifications.

70.02 MATERIALS. (a) Cable. The cable shall be manufactured of durable galvanized annealed steel having the properties as hereinafter specified.

The cable shall be composed of 3 strands, each strand having 7 wires. The diameter of the finished cable shall not be less than 3/4 inch. The wires composing the cable shall be of such quality that the finished cable shall satisfy all the requirements hereinafter set forth. All the wires in the cable shall be of the same grade of steel and shall have approximately the same ultimate strength.

The lay of the finished cable shall not be more than 7-1/2 inches. The lay of the wires in the strand shall not be more than 4-1/2 inches.

The diameter of the finished wires entering into the cable shall not be less than .117 inches and not more than .124 inches.

The minimum tensile strength of the cable shall be 20,000 pounds.

The wire shall be cylindrical in form and be free from scale, inequalities, flaws and splits.

Each wire from the cable shall be galvanized by the Hot Dip Method and shall have a continuous coating of pure zinc of a uniform thickness so applied that it will adhere firmly to the surface of the wire and it shall be capable of withstanding four immersions, in a standard testing solution of copper sulphate without showing any trace of metallic copper, of 1 minute each and the fourth immersion for a period of 1/2 minute.

All wire cable must be shipped upon substantial wooden reels. Each reel shall have the length and weight of the cable plainly and indelibly marked on a strong tag, firmly attached.

The wooden reel shall be mounted so that it will revolve and the cable run off by pulling straight ahead.

(b) Fittings. Turnbuckles shall be drop forged steel. Eyebolts shall be welded or drop forged.

All metal fittings including threads shall be galvanized after forming in accordance with the requirements for galvanized wire cable.

(c) Posts. The posts shall be 8 inches by 8 inches sawn posts

or round posts of Douglas Fir, Lodgepole Pine, Ponderosa Pine, Northern White Cedar, Western Red Cedar, Larch or Tamarack. Round posts shall have a diameter of not less than 8 inches nor more than 9 inches at the small end and shall be straight, sound, free from defects of all kinds and shall be peeled, shaved and thoroughly seasoned and dry when treated. They shall have been cut from live, green growing timber not less than 30 days in advance of treatment. Sawn posts shall be equal to the grade defined as select common in accordance with American Lumber Standards for soft wood lumber. Boxed heart will not be permitted in sawn posts. All posts shall receive an 8-pound empty-cell creosote pressure treatment in accordance with the provisions for the preservative treatment of timber structures as hereinbefore contained in Section "Preservative Treatment", or one of various salts treatments as herein provided for in Section 47.

70.03 CONSTRUCTION METHODS. The posts shall be set and tamped in a plumb and firm position to the depth, line and spacing shown on the plans or directed by the engineer. Fittings shall be installed as shown on the plans and the wire shall be tightened just enough to take up all the sag between the posts, the exact amount depending upon the temperature at which the fence is erected and making the allowance for the effect of change in temperature on the length of cable.

70.04 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. This item will be paid for at the unit price bid per linear foot of wire cable guard rail complete in place, measured from outside to outside of end posts; the price bid shall be full payment for all posts and cable, all materials, including anchors and all fittings, all excavation and backfilling, all equipment, tools, labor and incidentals.

SECTION 71

PAINTS FOR WOOD AND METAL

71.01 GENERAL REQUIREMENTS. All pigments shall be ground to such a fineness that all will pass a 325 mesh sieve. The paint shall not settle badly or cake, shall be readily broken up with a paddle to a smooth uniform paint of good brushing consistency and shall dry to a uniform texture without streaking, running or sagging when applied to a vertical surface.

When applied in a normal brushing coat under normal conditions of temperature and humidity, paint shall dry in not more than 24 hours.

71.02 PACKING AND MARKING. Paint shall be delivered in such containers as may be ordered. Each container shall bear a label with the following information shown thereon: Name and address of the manufacturer, shipping point, trademark or trade name, kind of paint, formula, number of gallons, date and lot number.

71.03 PREPARATION OF SURFACE. (a) Steel. Before applying any paint, all surfaces shall be thoroughly clean and dry. All scale and loose paint shall be removed. No painting shall be done under what the engineer judges to be adverse weather conditions. Paint and the steel being painted shall be at approximately the same temperature. Each coat of paint shall be allowed to dry at least 48 hours before the succeeding coat is applied.

(b) Wood. Before applying any paint all surfaces shall be thoroughly clean and dry. No painting shall be done under what the engineer judges to be adverse weather conditions. Guard rail and guide posts may be given the field prime coat at the mill or shop.

71.04 SAMPLING AND TESTING. No paints shall be used previous to the receipt of an acceptance report from the laboratory.

Unless otherwise specified all tests will be made in accordance with methods prescribed by the American Society for Testing Materials, or the American Association of State Highway Officials.

Representative samples of paints or paint ingredients shall be taken at the point of delivery and submitted to the Laboratory by the engineer.

Acceptance of paints or paint ingredients on the basis of a certified formula or analysis submitted by the manufacturer may be made at the discretion of the Materials Engineer.

71.05 MATERIALS. Ingredients used in the preparation of the various paints shall conform with the specifications listed below.

Material	ASTM	AASHO
1. Red Lead paste, 95% Grade	D 83	M 71
2. White Lead (basic sulphate)	D 82	M 123

3.	White lead (basic carbonate)	D 81	M 122
4.	Lampblack	D 209	---
5.	Zinc Oxide	D 79	M 124
6.	Iron Oxide	D 84	M 129
7.	Aluminum paste, type "A"	D 474	---
8.	Aluminum powder	D 266	---
9.	Raw linseed oil	D 234	M 125
10.	Boiled linseed oil	D 260	M 126
11.	Turpentine	D 13	M 127
12.	Drier	D 600	---
13.	Petroleum Spirits (Mineral Spirits)	D 235	M 128

14. Graphitic carbon shall conform with U. S. Navy Department Designation 14 G 4B.

15. Pigment for black paint for metals shall consist of graphitic carbon, red lead, iron oxide and insoluble siliceous mineral matter. The pigment shall show an analysis not less than 35 per cent carbon and 20 per cent lead oxide, calculated as PB_3O_4. The total of lead oxide, iron oxide, insoluble matter and loss on ignition shall not be less than 90 per cent.

16. Vehicle for black paint for metals shall contain not less than 80 per cent of raw linseed oil and the balance shall be combined drier and thinner. The thinner shall be turpentine, volatile mineral spirits, or a mixture thereof. If desired, the raw linseed oil may be replaced with boiled oil to the extent of 50 per cent of the total oil content.

17. Varnish vehicle for Aluminum paint shall conform with the following requirements:

Appearance:	Clear and transparent
Color:	Not darker than a solution of 3 grams of potassium dichromate in 100 cu. cent. of pure sulphuric acid, 1.84 specific gravity.
Non-volatile matter:	Not less than 50 per cent by weight.
Set to touch:	In not less than 2 hours and not more than 6 hours.
Dry hard and tough:	In not more than 24 hours.
Toughness:	Shall pass a 100 per cent Kauri Reduction test at 75 degrees F.
Viscosity:	(77° F.) Not less than 0.65 nor more than 1.25 poises. (Gardner-Holdt tubes B to E).

18. Titanium pigment shall contain at least 28 per cent of titanium dioxide, the remainder being precipated barium sulphate. Titanium dioxide and titanium barium shall be Class A, conforming with ASTM Specification D 476.

71.06 PAINTS FOR METALS.

(a) Red Lead Paint (Shop coat)

100 pounds red lead paste (7% raw linseed oil by weight.)
1-7/8 gallons raw linseed oil.
2-1/2 pints turpentine.
2-1/2 pints liquid drier.

(b) Red Lead Paint (First field coat used as undercoat for aluminum.)

100 pounds red lead paste (7% raw linseed oil by weight)
1-7/8 gallons raw linseed oil.
2-1/2 pints turpentine.
2-1/2 pints liquid drier.
Sufficient lampblack shall be added to give a light brown tint distinguishable from shop coat.

(c) Aluminum Paint (Second field coat)

2 pounds aluminum powder or paste.
1 gallon varnish vehicle.
Aluminum paint shall be mixed on the day it is used, except that "Ready mixed" paint, composed of aluminum powder and varnish meeting these specifications, may be furnished upon approval by the engineer provided that it maintains its "leafing" properties for, and is used within, a period of 2 weeks after mixing.

(d) Black Paint (First field coat)

Pigment, 35% to 40%
Vehicle, 60% to 65%
Water, maximum of 0.5%
Sufficient red lead shall be added to give a maroon tint.
Weight per gallon not less than 9.5 pounds.

(e) Black Paint (Second field coat)

Pigment, 35% to 40%
Vehicle, 60% to 65%
Water, maximum of 0.5%
Weight per gallon not less than 9.5 pounds.

(f) Gray Paint (First field coat)

25 pounds basic carbonate white lead paste (9% raw linseed oil by weight)
7/8 gallon raw linseed oil
1/2 ounce lampblack (dry pigment or its equivalent in paste)
1/4 pint turpentine
1/4 pint drier

(g) Gray paint (Second field coat)

25 pounds basic carbonate white lead paste (9% raw linseed oil by weight)
7/8 gallon raw linseed oil
2 ounces lampblack (dry pigment or its equivalent in paste)
1/4 pint turpentine
1/4 pint drier

71.07 PAINTS FOR WOOD.

(a) First Coat White (Prime)

100 pounds White Lead paste (9% raw linseed oil)
Basic Sulphate, Carbonate or a mixture thereof.
5 gallons raw linseed oil
2 gallons turpentine
1 pint drier

(b) Second Coat White (Body)

65 pounds white lead paste (9% raw linseed oil)
Basic Sulphate, Carbonate or a mixture thereof.
35 pounds zinc oxide paste (15% raw linseed oil)
3-1/2 gallons raw linseed oil
1-1/2 gallons turpentine
1 pint drier

(c) Third Coat White(Finish)

60 pounds white lead paste (9% raw linseed oil)
Basic Sulphate, Carbonate or a mixture thereof.
25 pounds zinc oxide paste (15% raw linseed oil)
15 pounds titanium paste (15% raw linseed oil)
4 gallons raw linseed oil
1 pint turpentine
1 pint drier

(d) Black Paint
20 pounds lampblack paste (containing not more than 75% linseed oil)
4-1/2 gallons of raw linseed oil
2 quarts of turpentine
1 pint of drier

SECTION 72

PROJECT MARKERS

72.01 DESCRIPTION. This item shall consist of furnishing and placing project marker posts at the beginning or end of projects where called for on the plans.

72.02 MATERIALS. Posts shall be constructed of Class D concrete, have a maximum size aggregate of 3/4 inch and reinforcing steel of the dimensions shown on the standard plans. Concrete and reinforcing steel shall conform to the specifications for these items as provided in Sections 49 and 50. The posts shall be capped with a cast bronze tablet free from defects and constructed in accordance with the design shown on the plans.

72.03 CONSTRUCTION METHODS. The posts shall be set three feet in the ground opposite the beginning and/or end of projects at exact locations staked by the engineer. Backfill around the posts shall be thoroughly tamped into place, such care being taken in backfilling and tamping that the post will not be shifted out of position.

72.04 BASIS OF PAYMENT. The number of project markers complete in place shall be paid for at the contract unit price bid for "Project Markers", which price and payment shall be full compensation for all material, tools, labor, equipment and incidentals necessary to complete the item.

SECTION 73

STATION MARKERS

73.01 DESCRIPTION. This item shall consist of the furnishing and placing of station marker posts where called for on the plans or directed by the engineer, the marker posts being generally set at every tenth station and at points of equation.

73.02 MATERIALS. Posts shall be 4 inches by 4 inches by 5 feet 0 inches, constructed of Class D concrete with a maximum aggregate size of 3/4-inch with reinforcing steel of the dimensions and placement shown on the standard plans. Class D concrete and reinforcing steel shall conform to the specifications for these items as provided in Sections 49 to 50.

The numerals may be recessed in the concrete or they may be of die-cast metal, of the size shown on the plans and shall be anchored in the concrete. The metal shall be non-rusting and dark in color. Any other approved method of showing station numbers, that is neat, legible and permanent, will be permitted.

73.03 CONSTRUCTION METHODS. Posts shall be set 2-1/2 feet in the ground at locations designated on the ground by the engineer. Holes shall be excavated of sufficient size to permit proper adjustment of the post to the lines required. Unless otherwise ordered in writing by the engineer, station markers will be set normal to the centerline at the station shown on the marker, the face of the marker farthest from the roadway to be 1 foot inside the right of way line.

73.04 BASIS OF PAYMENT. The number of station markers complete in place shall be paid for at the contract unit price bid for "Station Markers", which price and payment shall be full compensation for all material, tools, labor, equipment and incidentals necessary to complete the item.

SECTION 74

RIGHT OF WAY MONUMENTS

74.01 DESCRIPTION. This item shall consist of the furnishing and placing of right of way monuments at points where the width of right of way changes, and at other points designated by the engineer, such as curve and angle points.

74.02 MATERIALS. Posts shall be constructed of Class D concrete, have a maximum size aggregate of 3/4 inch, and reinforcing steel of the dimensions shown on standard plans. Concrete and reinforcing steel shall conform to the specifications for these items as provided in Sections 49 and 50.

74.03 CONSTRUCTION METHODS. The posts shall be set 2 feet in the ground at exact locations staked by the engineer. In general they shall be set so that the face of the monument farthest from the centerline coincides with the right-of-way line. Backfill around the posts shall be thoroughly tamped into place, care being taken to prevent shifting the post out of position during placing and tamping the backfill material.

74.04 BASIS OF PAYMENT. The number of right-of-way monuments complete in place shall be paid for at the contract unit price bid for "Right of Way Monuments," which price and payment shall be full compensation for all material, tools, labor, equipment, and incidentals necessary to complete the item.

ADDENDA

State Highway Commission

of Montana

CONTRACT

WITH

.....

Address.....

FOR

CONSTRUCTION OF

.....

.....County, Montana

.....Project No..... Date of Execution.....

Work Begun.....

Work Finished.....

Contractor's Number Mailed.....

CONTRACT

This Agreement, made in duplicate this_____day of _____A. D. 19_____, between the State of Montana, by the State Highway Commission, hereinafter called the party of the first part, and_____

_____

of_____, a corporation, incorporated under the laws of_____, its successors and assigns, party of the second part, hereinafter called the Contractor.

(This form when contractor is corporation.)

or

This Agreement, made in duplicate this_____day of _____A. D. 19_____, between the State of Montana, by the State Highway Commission, hereinafter called the party of the first part, and_____

_____

his, her, or their heirs, executors, administrators and assigns, party of the second part, hereinafter called the Contractor.

(This form when contractor is individual or copartnership.)

Witnesseth, That the Contractor, for and in consideration of the payment or payments herein specified and agreed to by the party of the first part, hereby covenants and agrees to furnish, and deliver and pay for all the materials, and to furnish all tools, machinery and implements, and to do and perform all the work and labor in the construction or improvement of a certain highway/bridge in_____,

_____County, State of Montana,

_____Project No._____, according to the dimensions and grades thereof this day agreed upon between the said parties and shown and stated in the plans and specifications hereto annexed, being approximately_____

_____

(_____) miles in length, at the unit prices bid by said

Contractor for the respective estimated quantities, aggregating approximately the sum of_____ Dollars ($_____) and such other items as are mentioned in_____ original proposal, which proposal and prices named, together with the annexed specifications are made a part of this contract and accepted as such, and also the plans of the improvement prepared by the State Highway Commission, are also agreed by each party as being a part hereof; the said improvement being situated as follows:_____

It is understood and agreed by and between the parties hereto that the work included in this contract is to be performed under and in accordance with the Standard Specifications for Road and Bridge Construction of the State Highway Commission of the State of Montana dated January 1st, 1945, which Standard Specifications are hereby made a part of this contract by this reference thereto.

It is understood by and between the parties hereto that the work included in this contract is to be done under the direction of the Engineer of the State Highway Commission and that his decision as to the construction and meaning of the drawings and specifications shall be final. It is also understood and agreed by and between the parties hereto that such additional drawings and explanations as may be necessary to detail and illustrate the work to be done are to be furnished by said Engineer, and the parties hereto agree to conform to and abide by the same so far as they may be consistent with the purpose and intent of the original drawings and specifications referred to herein. It is further understood that the work shall be subject to inspection at all times and approval by the United States Secretary of Agriculture, or his agents, and shall be performed in accordance with the laws of the State of Montana and the rules and regulations of the said Secretary of Agriculture made pursuant to that certain act of Congress approved July 11, 1916 (39 U. S. Statutes at Large, 335) entitled "An Act to provide that the United States shall aid the states in the construction of rural post roads, and for other purposes," and all Acts of Congress supplementary and amendatory thereto.

The contractor further covenants and agrees that he will well and truly pay all laborers, mechanics, subcontractors and material men who perform work or furnish material under this contract, and all persons who shall supply him and or the subcontractors with provisions, provender and supplies for the carrying on of the work.

The contractor further covenants and agrees that he will begin the actual performance of the work required and contemplated under this agreement within ten days after the date of the execution of

this contract and that all and every of the said materials shall be furnished and delivered and all and every respect to the satisfaction and approval of the engineer aforesaid on or before_____

_____. It is expressly understood and agreed that in case of the failure on the part of the Contractor, for any reason, except with the written consent of the State Highway Commission, to complete the furnishing and delivery of the said material and the doing and performance of said work on or before_____, the party of the first part shall have the right to deduct from any moneys due the contractor, or if no moneys shall be due, the party of the first part shall have the right to recover the amount of

_____Dollars ($_____)

per day, as fixed, agreed and liquidated damages, for each and every calendar day elapsing between the date above stipulated for completion and the actual date of completion and final acceptance; this in accordance with the paragraph of the Standard Specifications hereto annexed which refers to "Failure to Complete the Work on Time." Provided, however, that upon receipt of written notice from the contractor of the existence of causes over which said contractor has no control and which must delay the completion of the said work, the State Highway Commission may, at its discretion, extend the period hereinbefore specified for the completion of the said work, and in such case the contractor shall become liable for said liquidated damages for delays commencing from the date on which said extended period shall expire.

The contractor further covenants and agrees that he will without further expense to the party of the first part, remove all surplus soil and rubbish from off the said land and leave the said road and parts of the land or field adjoining it affected by such work, in the proper state, order and condition.

It is expressly understood and agreed that if the contractor fails to comply with any of the requirements of the plans or specifications, or shall discontinue the prosecution of the work, or if the contractor shall become insolvent or bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or from any other cause whatsoever shall not carry on the work in an acceptable manner, the Engineer shall give notice in writing to the contractor and his surety of such delay, neglect or default, specifying the same, and if the contractor within a period of three (3) days after such notice shall not proceed in accordance therewith, then the Commission shall, upon written certificate from the engineer of the fact of such delay, neglect or default and the contractor's failure to comply with such notice, have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said contractor, to appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement with any other person or persons for the completion of said contract according to the terms and pro-

visions thereof, or use such other methods as it may deem expedient for the completion of said contract in the specified manner. All costs and charges incurred by the Commission, together with the costs of completing the work under contract, shall be deducted from any moneys due or which may become due said contractor. In case the expense so incurred by the Commission shall be less than the sum which would have been apyable under the contract, if it had been completed by said contractor, then the said contractor shall be entitled to receive the difference; and in case such expense shall exceed the sum which would have been payable under the contract, then the contractor and the surety shall be liable and shall pay to the state the amount of said excess.

It is expressly understood and agreed that no claim for extra work or materials, not specifically herein provided, done or furnished by the contractor, will be allowed by the State Highway Commission, nor shall the contractor do any work or furnish any materials not covered by these specifications and contract unless such work is ordered in writing by the Engineer. In no event shall the contractor incur any liability by reason of any verbal directions or instructions that he may be given by the said Engineer, or his authorized assistant; nor will the said party of the first part be liable for any extra materials furnished or used, or for any extra work or labor done, unless said materials, work or labor are required by said contractor on written order furnished by the said Engineer. Any such extra work or materials which may be done or furnished by the contractor without such written order first being given shall be at said contractor's own risk, cost and expense, and he hereby covenants and agrees that without such written order he shall make no claim for compensation for work or materials so done or furnished.

The contractor further covenants and agrees that during the progress of the work to be performed under the provisions of this contract, he will in every respect comply with the provisions of the Workmen's Compensation Act, being Chapter 96 of the Session Laws of the 14th Legislative Assembly of the State of Montana, and with all statutory provisions supplementary or amendatory thereto.

In case any question or dispute arises between the parties hereto respecting any matter pertaining to this contract, or any part thereof, said questions or disputes shall be referred to the State Highway Commission and Attorney General of the State of Montana, whose decisions shall be final, binding and conclusive upon all parties without exception or appeal; and all right or rights, of any action at law, or in equity, under and by virtue of this contract, and all matters connected with it and relative thereto are hereby expressly waived by the contractor.

It is expressly understood and agreed that the contractor will notify the State Highway Commission in writing of the date upon which his work will be completed and ready for final inspection; that upon receipt of such notice from the contractor the Engineer will arrange for a final inspection of the work, such inspection to be had within fifteen days of the date specified in such notice from the contractor; that final payment for the work will be made within ninety days of the date of the final acceptance of the project by

the Engineer.

The contractor further agrees that he will save and keep harmless the said State of Montana against and from all losses to it from any cause whatever, including patent, trade mark and copyright infringements in the manner of constructing such section of roadway.

The contractor hereby further agrees to receive the following prices as full compensation for furnishing all the material and labor which may be required in the prosecution and completion of the whole of the work to be done under this contract or agreement, and in all respects to complete said contract to the satisfaction of the State Highway Commission; it being understood and agreed by and between the parties hereto that ninety per cent (90%) of the amount due for the completion of work during any working month, inclusive of "extra work" and "extra materials," when and only when such amount is in excess of five hundred dollars ($500.00) shall be paid to the contractor by the party of the first part within thirty days after the expiration of that working month, and all unpaid balances due on the final estimate shall be paid similarly to the contractor within ninety days after the final acceptance of the contract, as provided in the second paragraph supra; the estimate in all cases of the work completed during any working month as well as the final estimate, to be prepared by the Engineer of the State Highway Commission or his authorized assistant.

(Here refer to schedule of bid prices submitted by contractor with his Proposal Form, which schedule and Proposal Form are inserted and, by agreement of both parties, are made a part of the Contract.)

It is expressly understood and agreed by and between the parties hereto that as a condition precedent to the complete execution of this contract, the contractor will furnish a good and

sufficient surety bond in the amount of_____

_____Dollars ($_____) to be conditioned upon the faithful performance of the covenants and agreements as herein set forth by him to be performed, subject to the approval by the Chairman of the State Highway Commission and the Attorney General of the State of Montana.

(Incorporated firms sign below.)

In witness whereof the Chairman of the State Highway Commission, by authority in him vested, has hereunto subscribed his name on behalf of the State of Montana and affixed the seal of the State

Highway Commission, hereto, and the said_____
has hereto attached his corporate seal duly attested by the signature of its duly authorized officers, the day and year first above written.

Attest: STATE OF MONTANA

_____ By _____
Secretary. Chairman of the State Highway Commission.

Attest: _____
Contractor.

_____ By _____
Secretary. President.

Approved as to form and legality:

_____
Attorney General.

By _____
Assistant.

(Individual contractors or co-partnership firms sign below.)

In witness whereof, the Chairman of the State Highway Commission, by authority in him vested, has hereunto subscribed his name on behalf of the State of Montana and affixed the seal of the State Highway Commission, hereto and the said _____ hereunto set _____ hand ___ and seal __, the day and year first above written.

Attest: STATE OF MONTANA

_____ By _____
Secretary. Chairman of the State Highway Commission.

WITNESSES:

_____ (Seal)
Contractor.

_____ _____ (Seal)

_____ _____ (Seal)

_____ (Seal)

_____ (Seal)

Approved as to form and legality:

_____
Attorney General.

By _____
Assistant.

CONTRACT BOND

KNOW ALL MEN BY THESE PRESENTS, That we,_____

_____

_____

hereinafter called the "Principal" and_____

_____

_____

a corporation licensed under the laws of the State of Montana, hereinafter called the "Surety" are held and firmly bound unto the State of Montana in the full and just sum of_____

_____Dollars ($_____) lawful money of the United States of America, to be paid to the State of Montana, or its assigns, to which payment well and truly to be made and done, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

Sealed with our raspective seals and dated this_____

day of_____, 19_____.

WHEREAS, The above bounden "Principal" has entered into a contract with the State of Montana, by the State Highway Commission, through its Chairman, bearing even date herewith, for the improvement construction of a certain section of highway/bridge_____in

_____County, State of Montana,_____

Project No._____being approximately_____

_____(_____) miles in length for approximately

the sum of_____Dollars ($_____)

the said highway/bridge___being situated as follows:_____

_____

_____

_____

_____

_____

and,

WHEREAS, It was one of the conditions of the award of the State Highway Commission, acting for and on behalf of the State of Montana, pursuant to which said contract was entered into, that these presents should be executed;

NOW, THEREFORE, The condition of this obligation is such that if the above bonded "Principal" as Contractor shall in all respects faithfully perform all of the provisions of said contract, and his, their or its obligations thereunder including the specifications therein referred to and made part thereof and such alterations as may be made in said specifications as therein provided for, and shall well and truly, and in a manner satisfactory to the State Highway Commission, complete the work contracted for, and shall save harmless the State of Montana, from any expense incurred through the failure of said Contractor to complete the work as specified, or from any damages growing out of the carelessness of said Contractor or his, their, or its servants, or from any liability for payment of wages due or material furnished said Contractor, and shall well and truly pay all laborers, mechanics, subcontractors and material men who perform work or furnish material under said contract, and all persons who shall supply him or the subcontractor with provisions, provender and supplies for the carrying on of the work, and also shall save and keep harmless the said State of Montana against and from all losses to it from any cause whatever including patent, trademark and copyright infringements, in the manner of constructing said section of work, then this obligation to be void or otherwise to be and remain in full force and virtue.

WITNESSES: _____(Seal)

_____(Seal)

_____(Seal)

_____ _____(Seal)

_____ _____(Seal)

_____(Seal)

Attest: _____(Seal)

_____ _____
Ass't. Secretary Surety Company.

By_____
(Seal) Attorney-in-Fact.

Approved as to form and legality:

_____
Attorney General.

By_____
Assistant.

APPROVAL OF STATE
AUDITOR

ACTS RELATING TO LIENS

An Act Requiring That Any Board, Council, Commission, Trustees or Body Acting for the State of Any County or Municipality or Any Public Body, Who Shall Contract with Any Person or Corporation to do Any Work for the State, County, Municipality or Other Public Body, to Require a Good and Sufficient Bond Therefore, and Providing the Terms, Conditions and Provisions of Said Bond, and Prescribing the Liability of the State or Any County or Municipality or Public Body for Failure to Take Such Bond and Repealing All Acts or Parts of Acts in Conflict Herewith.

BE IT ENACTED BY THE LEGISLATIVE ASSEMBLY OF THE STATE OF MONTANA:

Section 1. Whenever any board, council, commission, trustees or body acting for the state, or any county, municipality or any public body, shall contract with any person or corporation to do any work for the state, county, or municipality or other public body, city, town or district, such board, council, commission, trustees or body shall require the corporation, person or persons with whom such contract is made, to make, execute and deliver to such board, council, commission, trustees or body, a good and sufficient bond with two or more sureties, or with a surety company as surety, conditioned that such corporation, person or persons shall faithfully perform all of the provisions of such contract, and pay all laborers, mechanics, subcontractors and material men, and all persons who shall supply such corporation, person or persons, or subcontractors with provisions, provender, material, or supplies for the carrying on of such work, a copy of such bond shall be filed with the county clerk and recorder of the county where such work is performed or improvement made, or if to be performed in more than one county, then with the county clerk of either county, except in cases of cities and towns, in which case such bond shall be filed with the city or town clerk thereof; and any corporation, person or persons performing such services, or furnishing such provender, provisions, supplies, or material to any subcontractor shall have the same right under the provisions of such bond as if such work, services, provender, provisions, supplies or material, was furnished to the original contractor; provided, however, that the provisions of this Act shall not apply to any money loaned or advanced to any such contractor, subcontractor or other person in the performance of any such work.

Section 2. Every person, firm or corporation furnishing provender, provisions, materials or supplies to be used in the construction, performance, carrying on, prosecution or doing of any work for the state, or any county, city, town, district, municipality or other public body, shall not later than seven (7) days after the date of the first delivery of such provender, material, supplies or provisions to any subcontractor or agent of any person, firm or corporation having a sub-contract for the construction, performance, carrying on, prosecution or doing of such work, deliver or send by registered mail to the contractor a notice in writing stating in substance and

and effect that such person, firm or corporation has commenced to deliver provender, provisions, materials or supplies for use thereon, with the name of the subcontractor or agent ordering or to whom the same is furnished, and that such contractor and his bond will be held for the same, and no suit or action shall be maintained in any court against the contractor or his bond to recover for such provender, provisions, material or supplies, or any part thereof, unless the provisions of this Act have been complied with.

Section 3. If any board, council, commission trustees or body acting for the state, or any board of county commissioners or any mayor and common council of any incorporated city or town, or tribunal transacting the business of any such municipal corporation, shall fail to take such bond as herein required, the state or such county, incorporated city or town, or other municipal corporation shall be liable to the persons mentioned in Section 1 to the full extent and for the full amount of all such debts so contracted by any such subcontractor as well as such contractor.

Section 4. (As amended by Chapter 96 of the 27th Legislative Assembly Session Laws.) The bond mentioned in Section 1 shall be in an amount equal to the full contract price agreed to be paid for such work or improvement, and shall be to the State of Montana, except in cases of cities and towns, in which case such municipality may, by general ordinance, fix and determine the amount of such bond, and to whom such bond shall run; provided, that the same shall not be for a less amount than twenty-five per centum (25%) of the contract price of any such improvement, and may designate that the same shall be payable to such city or town and not to the State of Montana. All such persons mentioned in said Section 1 shall have a right of action in his or her or their own name or names, on any bond furnished under the terms of this act for work done by such laborers or mechanics and for provender, materials, supplies, provisions or goods supplied and furnished in the prosecution of such work or the making of such improvements; provided, that such persons shall not have any right of action on such bond for any sum whatever, unless within thirty (30) days from and after the completion of the contract with an acceptance of the work by the affirmative action of the board, council, commission, trustees, officer or body acting for the state, county or municipality or other public body, city, town or district, the laborer, mechanic or subcontractor, or material man or person claiming to have supplied provender, materials, provisions or goods for the prosecution of such work, or the making of such improvement, shall present to and file with such board, council, commission, trustees or body acting for the state, county or municipality or other public body, city, town or district, a notice in writing in substance as follows:

"TO (here insert the name of the state, county, or municipality or other public body, city, town or district):

NOTICE IS HEREBY GIVEN that the undersigned (here insert the name of the laborer, mechanic or subcontractor, or materialman, or person claiming to have such furnished labor, materials or provisions for or upon such contract or work) has a claim in the sum of_____

_____Dollars (here insert the amount)

against the bond taken from_____
(here insert the name of the principal and surety or sureties upon

such bond) for the work of_____
(here insert a brief mention or description of the work concerning which said bond was taken).

(Here to be signed)_____"

Such notice shall be signed by the person or corporation making the claim or giving the notice, and said notice, after being presented and filed, shall be a public record open to inspection by any person, and in any suit or action brought against such surety or sureties by any such person or corporation to recover for any of the items hereinbefore specified, the prevailing party shall be entitled to recover in addition to all other costs, attorneys' fees in such sum as the court shall adjudge reasonable; provided, however, that no attorneys' fees shall be allowed in any suit or action brought or instituted before the expiration of thirty (30) days following the date of filing of the notice hereinbefore mentioned; and provided further, that any city or town may impose any other or further conditions and obligations in such bond as may be deemed necessary for its proper protection in the fulfillment of the terms of the contract secured thereby, and not in confliot herewith."

Section 5. All acts and parts of acts in conflict herewith are hereby repealed.

SUPREME COURT DECISIONS.

Kirkpatrick Bros. vs. A. R. Douglas, et al., 104 Mont. 212 and/or 65 Pac. (2nd) 1169.

H. Earl Clack Company vs. Thomas Staunton, 104 Mont. 375 and/or 72 Pac. (2nd) 1022.

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